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QUARTERLY

OF THE

National Fire Protection Association

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87 MILK STREET BOSTON, MASS.

National Fire Protection Association.

(INTERNATIONAL.)

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Western Actuarial Bureau (Fire).
Western Canada Fire Underwriters' Association.
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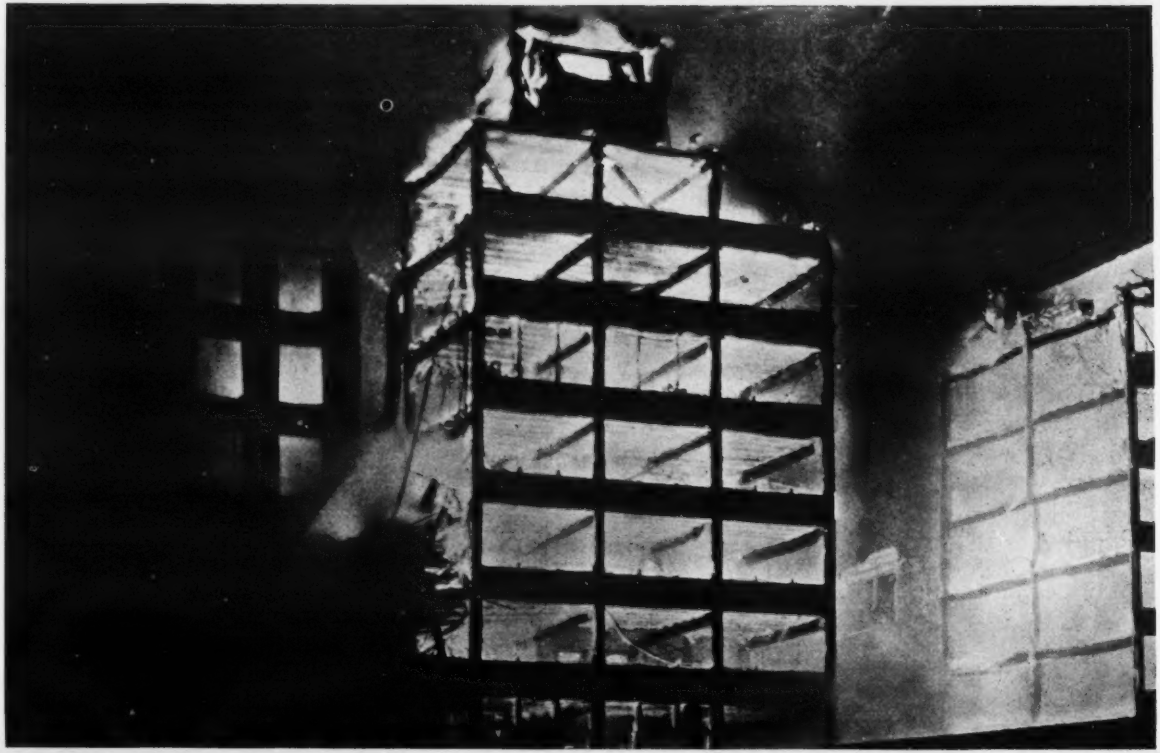
Reports of fires appearing in the Quarterly are copies of or extracts from written reports forwarded to the Association. This Association, as a body, is not responsible for the statements or opinions of any of its members.



International **One of the first pictures of the Chicago fire of March 15, 1922.**

The Quarterly

Vol. 15 April, 1922 No. 4

Twenty-Sixth Annual Meeting. It is twenty years since the members of the N. F. P. A. took a dip together in the ocean at Atlantic City. The Sixth Annual Meeting was held in May, 1902, at Philadelphia, and at the close of the convention the members went to Atlantic City for a frolic. At that time the reputation of the seaside resort for conventions was not, as now, so thoroughly established. In spite of its name for gaiety Atlantic City is an admirable place for the accomplishment of serious work. The days there are quiet and uneventful. All the unique features of the place except perhaps the bathing can be enjoyed in the evening. The noises of the large city are absent and the deliberations of a convention can proceed therefore without distractions from the outside.

The headquarters and place of meeting for the May Convention (May 9, 10, 11) is Chalfonte-Haddon Hall, two hotels under the same management, on the sea front, on opposite sides of North Carolina Avenue. The sessions will be held in the Vernon room of Haddon Hall, a spacious and elegant chamber of adequate capacity with doors opening on one side upon a wide gallery facing the sea, and on another upon a beautiful garden room and a fountain court. The official program to be mailed to members shortly and the announcements in the *News Letter* will indicate the budget of committee reports to be presented and other items of the meeting.

* * * * *

Motion Picture Film Hazard. The announcement in the *News Letter* of the inauguration, by the two manufacturers now supplying the American markets with slow-burning motion picture film, of the practice of marking this film in such manner that any portion of its length may be identified by the user, marks a definite step in progress toward controlling the use of the gun-cotton film by non-professionals. The principal volume of slow-burning film now in use is in the narrow or non-professional width and one is reasonably secure in assuming that the narrow-width film is safety film. There is, however, no physical barrier to the making of narrow films on a nitro-cellulose base, and certain picture reels were so made and were rejected by the state safety department of Massachusetts during the war. The expanding desire for pictures on the full or professional width film for non-professional use is promoting the production of an increasing number of such films. Without injustice to the latter, therefore, differences in width can

no longer be made the criterion of the safety film, but every film of whatever width should be marked for proper identification and safety stocks should be checked up occasionally by reliable inspection agencies to insure the integrity of the markings.

It is fortunate that almost at the beginning of the production of the full-width safety film for non-professional use the manufacturers have agreed to give it a distinctive marking, as this will assist it materially in making its proper way. For during the period of transition from the present sly and illegal if not the wholly ignorant display of guncotton film pictures by non-professionals in rooms not properly safeguarded, to the frank, honest and safe adoption of the safety film in the professional width for popular pictures (which can and should be allowed to be displayed without a booth) there is no resource but to reject the unmarked film when presented in the professional width. Where a safety-film picture appears in this width upon unmarked stock there is always the resource of clipping off a piece of it for a flame test, or putting a rider upon it certifying to its good character.

* * * * *

Picture Films and the Laws. The attempted control of this matter by public authorities emphasizes rather sharply the advantages in matters of public safety of a flexible administration such as a state commission over the rigid prohibitions of state laws and ordinances. States like Pennsylvania and Wisconsin, in which motion picture film hazards are controlled by their industrial commissions, can recognize new developments and readjust rulings to conform to them. The coming of the safety film in the professional width must upset the laws and ordinances of those states and cities which prohibit the display without a safety booth of any film anywhere except those of the narrow non-professional width. These laws will continue to block progress and inflict hardship until the minds of the legislatures and city councils occupied by other matters can be directed to the importance of this item and prevailed upon to give it proper consideration.

Another law against which the forces of those who understand the matter must be directed is that common to many states which permits if it does not require the use of the portable motion picture booth where inflammable film is displayed outside of motion picture houses or other establishments in which a permanent booth is provided. The exhaustive tests of the portable booth by Underwriters' Laboratories, reported at length in this issue of the QUARTERLY, with the inevitable conclusion that it is wholly unreliable for the purpose for which it was designed, make the laws which recognize it as a protective agency unwise if not actually mischievous, and drive another nail in the coffin of the gun-cotton film. All enlightened opinion points to but one solution of the safe use of motion pictures by non-professionals; the complete prohibition of the nitro-cellulose film in connection with such displays and the encouragement of the printing upon slow-burning film of every sort of picture desired for non-professional projection. A committee of the N. F. P. A. has been appointed to work for this end and as its efforts are to be directed by the energy and tact of former president F. J. T. Stewart of New York there can be no doubt, in spite of the magnitude of the task, that definite accomplishments must result.

Dust Explosion Hazards Book. There is now in preparation, for early publication by the N. F. P. A., a book of unusual value on the subject of dust explosion hazards. The authors are two members of the Association, Dr. David J. Price of Washington, Engineer in charge of development work, Bureau of Chemistry, U. S. Department of Agriculture, and Dr. H. H. Brown, now of Boston, formerly associated with Dr. Price in the government's grain dust explosion investigations carried on during the war. The book is to contain all the valuable information on this subject collected in these investigations, much of which is not now available elsewhere, with additions of matter of more recent date on other explosive dusts, and is published by special consent of the Secretary of Agriculture. The generous extent of the contribution made to the N. F. P. A. by the two distinguished members who have written this book will be appreciated when it is stated that its preparation is wholly a labor of love by Dr. Price and Dr. Brown, who are to receive no royalties nor other compensation from the sale of the book. It is to be an expensive book to publish, with its diagrams, photographs and tables, especially at present high prices of book production, but there is nothing of the sort now available anywhere and it is believed enough copies may be sold inside our membership and out to warrant its publication. It is published by the N. F. P. A. not as a commerical venture but as an up-to-date contribution upon a subject which grows in importance as it is the better understood, and it is written for the understanding and guidance of the laymen of the dust-producing industries and all others who may be interested in the behavior and hazards of explosive dusts. A bulletin will shortly be issued with the size, contents and selling price of the book duly indicated. It will be sold at the lowest price its publishing cost will permit.

* * * * *

Three New Committees. It is seldom that a new committee is created by the executives in the middle of the Association year. All the more remarkable that there were three brought into being at the midwinter meeting on January 27th. One of these would have been created in July had consideration of it not been referred to the Committee on Building Construction. This is the committee proposed at the San Francisco meeting by the late W. C. Robinson, vice-president of the Association (See *Proceedings* 1921, p. 389), to study the time element or duration of fires in buildings of given occupancies. Mr. Henry V. Thayer of Boston was named as chairman of this committee.

A second committee, one on the Storage of Combustible Fibres, was appointed, with Mr. R. P. Strong of New Orleans as chairman. The need for this committee, which is to investigate the storage and handling of both hard and soft fibres (sisal, jute, hemp, cotton, etc.), appeared following a discussion of the hazards of sisal about which a thorough understanding does not yet seem to exist.

The need for the third committee became apparent in a review of the text of the new book on Dust Explosion Hazards to be published shortly by the Association. A code for the safeguarding of industries producing explosive dusts seemed imperative enough to warrant beginning work at once on this subject. Dr. David J. Price of Washington is to be chairman of this committee.

Presumably we shall have no reports from any of these three new committees at the May meeting although it is possible Dr. Price may present a preliminary informative report outlining the nature of the work of his committee and illustrating by pictures or other exhibits the importance of it.

* * * * *

Field Practice: N. F. P. A. Inspection Manual. The long-expected revised edition of *Field Practice*, the Association's useful and popular inspection manual is now in the hands of the printer and barring any mishap will be available by May 1st to the members who are patiently waiting for it. That five thousand copies of the first edition, printed in 1914, are now in use in all parts of the world, testifies to the real value of this book, the least expensive and yet most helpful and unique inspection manual available to the fire protection fraternity. The revised edition will invalidate nothing in the edition now in use. Certain chapters have been rewritten in the interest of clearer expression; certain matter, especially on first aid appliances, has been added. Orders for several hundred copies await delivery on publication and the desire for the book becomes more widespread as fire prevention education progresses. The cost of producing the new edition is almost double that of the edition of 1914, but the selling price is to remain $1.50. A well-chosen imitation leather is to be the binding of the new edition. The real grain leather cover of the 1914 edition could be duplicated only by increasing the price of the book and the modern artificial leathers are quite satisfactory in wearing qualities. Announcement will be made in the *News Letter* when the book is ready.

* * * * *

Radio Signaling Apparatus Hazards. A member familiar with the business of wireless telephony, which is now attracting so much popular attention, stated recently that the sales of apparatus of this character have increased ten-fold during the last year or two, the present demand being so great as to tax the capacity of the factories turning out radio material. Radiophone "broadcasting" of concerts, lectures and various forms of entertainment is becoming a veritable epidemic. Reports that the federal government intended to curb this practise were presumably based upon the announcement of plans for its regulation merely. It is stated that the government itself is preparing to broadcast weather and market reports and health bulletins.

The fire hazards of radio apparatus are sufficient to make regulation of this feature desirable, to make sure that the installations are properly made. Installations are multiplying sufficiently in New York City to lead the New York Board of Fire Underwriters (member N. F. P. A.) to issue a special bulletin on the subject. Attention is called to the fact that the installation of wires or other conductors outside of buildings and the extension of these conductors to radio apparatus inside buildings for receiving only, or both sending and receiving, may introduce a considerable fire hazard due chiefly to lightning, unless the necessary safeguards are provided.

The bulletin says:

Induced charges of electricity in exposed aerial wires due to lightning discharges are likely to enter the premises and unless suitable precautions have been provided fires are likely to follow. The ground wire necessary for outside antenna (aerial wires) should be kept out of the building as far as possible and be connected to a permanent ground, preferably to the water piping in the cellar or basement.

Where the antenna is entirely within the building, the fire hazard due to radio signaling apparatus for "receiving" only is relatively small and its installation requires no special safeguards unless current is taken from the light or power circuit.

All wireless installations for "sending" and all installations having outside exposed aerial lines (antenna) for "receiving," or having connection with a light or power circuit, should be approved by certificate from this Board.

It is important that the apparatus be shut off and the aerial wires connected directly to the "ground" wire during all lightning storms and at all times when not in use.

The dream of Edward Bellamy contained in his novel "Looking Backward" which attracted so much attention twenty-five years ago has become a reality. One may now sit in his library and listen to a concert on a night of bad weather. The radiophone holds a wonderful potential development in further advances of world civilization.

* * * * *

Another Picture Film Disaster. Harrisburg, Pennsylvania, is at this writing the latest city to pay tribute, through personal injuries to its firemen and eighteen of its citizens, to the use of the nitro-cellulose motion picture film by the motion picture industry.

At 226 Chestnut Street, Harrisburg, films were repaired in a basement above which were a store and apartments. The evening of February 18th, after closing, film or film scrap was ignited by the heat of a steam pipe. The fire department responded to a telephoned alarm. The firemen did not know there were films in the basement. They inquired of the owner, but he gave them no answer. Three of them went down the basement steps but before they had opened the glass-paneled door through which the fire could be seen, two of them were blown fifteen feet into the street and the third prostrated upon the steps. Eighteen spectators were burned by the blast of flame, some of them severely; all of them badly enough to require hospital treatment. On March 10th, Fire Chief Marion Verbeke reported two of the firemen still in the hospital but slowly improving.

A perfectly safe film is available for motion pictures but as it costs a fraction of a penny more per foot and the industry is not yet held liable for the property loss and personal injury resulting from its use, the gun-cotton variety is still adhered to.

Meeting of Executive Committee.

The midwinter meeting of the executives was held in New York City on January 27th, 1922. The following members were present:

Rudolph P. Miller, New York, Chairman
A. T. Bell, Atlantic City
J. H. Brumbaugh, Chicago
Geo. H. Greenfield, Montreal
John B. Laidlaw, Toronto
H. L. Miner, Wilmington, Del.
Dana Pierce, New York
F. B. Quackenboss, Nashville
Benj. Richards, Chicago
Willis O. Robb, New York
Robert Scott, Wilmington, N. C.
W. E. Mallalieu, New York, President
F. J. T. Stewart (N. Y.), Past-President
Louis Wiederhold, Jr., Philadelphia, Past-President
Franklin H. Wentworth, Boston, Secretary-Treasurer.

Business Transacted.

The specifications for *Small Hose Couplings* as presented by the committee to the annual meeting of 1921 *were adopted* as standard.

The Committee on Automatic Sprinklers was requested to prepare for presentation to the Association regulations for the installation of stationary automatic soda-acid sprinkler systems using liquids.

The action of the Electrical Committee in voting to include in the next revision of the National Electrical Code consideration of hazards to life as well as property was *approved.*

Further consideration was given to the matter of the acceptance by the N. F. P. A. of the appointment by the American Engineering Standards Committee as joint sponsor with the U. S. Bureau of Standards for the preparation of a combined electrical fire and safety code, and the Secretary was requested to correspond with the Bureau of Standards, suggesting joint action in advising a suspension of the present Sectional Committee of the A. E. S. C. charged with this responsibility.

A report from the Committee on Building Construction, to which was referred the matter of the appointment of a committee to collect information as to the duration of fires in various occupancies, was considered, and the President and Secretary were authorized to appoint a special committee on this subject.

A request from the Committee on Automatic Sprinklers that provision be made for financing a test program by Underwriters' Laboratories to furnish a check on the adequacy of present sprinkler spacing and distribution was referred to the President and Secretary for conference with the interests affected.

A communication from the Dominion Fire Commissioner of Canada suggesting the desirability of the appointment of a United States commit-

tee to confer with a Canadian committee undertaking an investigation of the present commercial system of grain handling, looking toward an improvement in the same respecting the hazards of grain dust explosions, was referred to the President and Secretary, and authority given these officers to undertake the formation of such a committee, should investigation of the subject indicate desirability of such initiative on the part of the N. F. P. A.

The President and Secretary were authorized to create an N. F. P. A. committee to prepare regulations for safeguarding industries against dust explosions.

The action taken by the executives at their last meeting adopting the revised regulations for the installation and use of internal combustion engines as submitted by the Committee on Gases following report to the annual meeting of 1921 was rescinded, and permission given to the committee to submit the proposed changes to the Association for adoption at the next annual meeting.

It was *voted* to endorse, as a member of the Fire Protection Group, the amendment to the constitution of the American Engineering Standards Committee modifying the provision for time limits on the revision of standards to be adopted by the A. E. S. C.

It was *voted* that the Secretary be requested to prepare a bulletin for transmission to state fire marshals, newspaper editors, etc., on the subject of the abnormal fire waste of the past year, urging renewed efforts for its curtailment.

Consideration was given to the request from the National Safety Codes Committee, a standing committee of the A. E. S. C., that a representative of the N. F. P. A. be appointed to that body. Mr. Dana Pierce was appointed for this service.

On request of the Electrical Safety Conference that the N. F. P. A. appoint a representative upon the A. E. S. C. Sectional Committee on Safety Code for Electrical Power Control, Mr. William Newell was appointed as such representative.

It was *voted* to adopt the revised ordinance of the National Board of Fire Underwriters for the Construction of Chimneys, and to circulate the same among the Association membership.

In response to a communication from the Chairman of the Committee on Fire Protection of the American Institute of Architects, Mr. A. M. Schoen was selected to represent the Institute upon the Sectional Committee on Lightning Protection of the A. E. S. C.

The program for the annual meeting was discussed, and matters relating thereto referred to the Program Committee.

The suggestion of an organization member that a field secretary be provided by special subscription on the part of members desiring to promote such development was referred to the Finance Committee for consideration and report to the Executive Committee.

At the request of the American Society of Mechanical Engineers, one of the sponsors for a Sectional Committee of the A. E. S. C. on the Standardization of Pipe Flanges and Fittings, that the N. F. P. A. be represented on such sectional committee, Mr. Walter O. Teague, Chairman of the N. F. P. A. Committee on Standardization of Pipe and Pipe Fittings, was appointed as such representative.

The following additions were made to present committees of the Association:

To the Electrical Committee:
J. W. COWLES, Boston, Mass., representing the Association of Edison Illuminating Companies.

To the Committee on Building Construction:
DUDLEY HOLTMAN, Washington, D. C., representing the National Lumber Manufacturers' Association.

To the Committee on Inflammable Liquids:
W. C. SWEETMAN, Chicago, Ill., representing the Oil Insurance Association.

To the Committee on Manufacturing Risks and Special Hazards:
W. C. SWEETMAN, Chicago, Ill., representing the Oil Insurance Association.

To the Committee on Docks, Piers and Wharves:
DE WITTE RAPALJE, New York, representing the Railroad Insurance Association.
E. C. SHANKLAND, Chicago, representing the American Institute of Consulting Engineers.
PAUL A. BISSELL, Boston.

Having tried the soothing powers of music without avail, wouldn't it be well to use a club (PERSONAL LIABILITY LAWS)

Courtesy Whitlings

The Protection of Historic Public Buildings.

IV. Faneuil Hall—Boston.

Faneuil Hall, "the Cradle of Liberty," is one of the most picturesque and interesting of historic buildings in America. Located in the heart of Boston it is today much the same as when erected one hundred and eighty years ago. The busy markets and the stately public hall are still centers of public activity as in past years. The same hall where so much history was made is still used for political and public gatherings. It is unlike most other historic shrines in this respect. There are few old buildings that have remained a part of the life of the nation. The preservation of this building has been made possible through excellent and thorough reconstruction. However, there is a definite fire hazard involved in the wooden construction of the basement, inadequate fire protection, and a severe exposure by neighboring buildings.

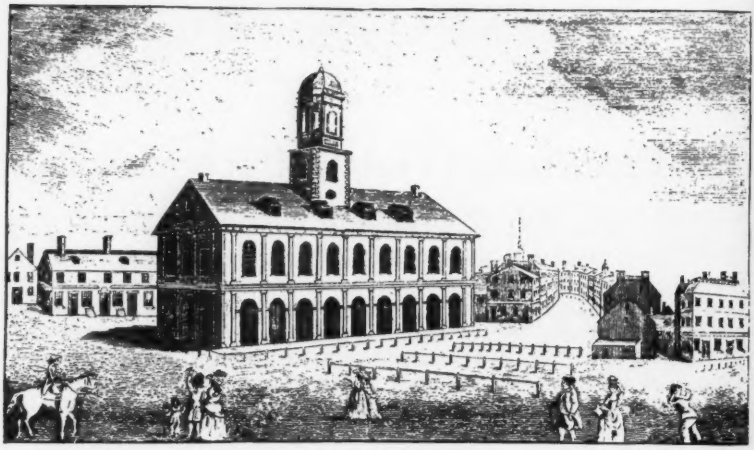
History.

The need of a public market place was evident in the early days of the Massachusetts colony. In 1656 the will of Robert Keayne provided a town house and market. This building was burned down in 1711. (See article on The Old State House, page 113, October, 1921, QUARTERLY.)

Considerable opposition to a new market developed among certain traders, but after much discussion and debate the town authorities erected a market in Dock Square, the present site of Faneuil Hall. Not much is known of this building but it must have been a rather unsubstantial affair as it met an untimely end at the hands of opponents of the scheme. These, one dark night, disguised themselves as clergymen and demolished the structure. This was in 1737. Three years later, Peter Faneuil, a prominent and rich merchant, petitioned for a public market and in 1742 he presented the building to the town. As can be seen by the illustration it was a two-story brick structure, the lower floor being used for market stalls and the upper as a public hall. So well built are the walls that they are standing at the present day after undergoing both earthquake and fire.

In 1755 an earthquake shook the building although no damage was incurred except that the famous grasshopper weathervane, hammered by hand out of sheet copper by Deacon Shem Drowne in 1740, was thrown down and had to be repaired.

Note: This is the fourth of a series of articles on the fire protection of important public buildings of historic interest. The fifth will appear in an early issue.—Ed.



Faneuil Hall as it appeared in 1763, when rebuilt after the fire of 1761.

The second calamity occurred in 1761. Little is known of the details. In the words of the *Boston News Letter* of January 15th of that year:

> Fire broke out in a shop in Dock Square and crossed the street to that stately edifice, Faneuil Hall Market, the whole of which was soon consumed, excepting the brick walls, which are left standing.

There being no money to repair the damage, the voters of Boston directed the Selectmen to petition the General Court for an act enabling them to conduct a lottery. They set forth in their preamble that:

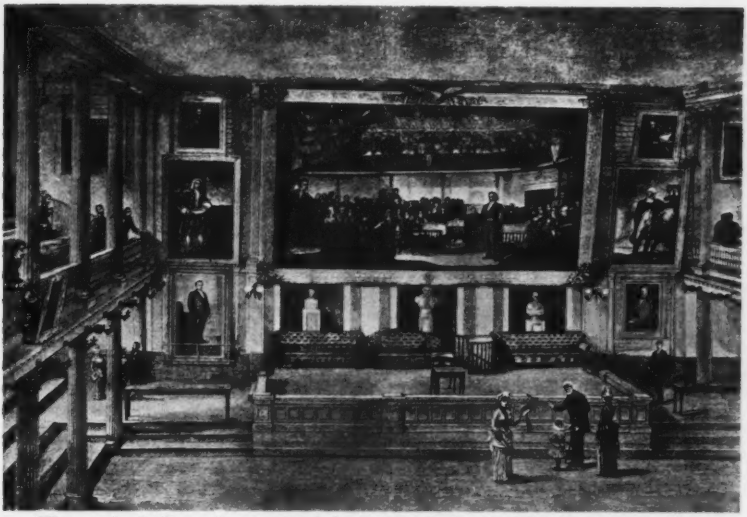
> "In the providence of God, Faneuil Hall having been consumed by fire, the inhabitants of said town labor under great inconvenience in want of a suitable place for transacting business of said town, and find it necessary to rebuild and repair the said hall not only to accommodate themselves, as soon as may be, but also that they may not lose the benefit of the walls yet standing."

The money was raised and the hall rebuilt, covering it with a slate roof, putting in stone window frames and using as little woodwork as possible.

During the stirring years that followed, the building became the political center of the town and because of the many important political meetings held therein both before and during the Revolution it became known as "The Cradle of Liberty." It was here that the stamp tax demonstrations, and the meetings of 1773, culminating in the Boston Tea Party, were held. During the occupation of the town by the British the hall was used as a theatre for British officers. Upon Washington's election to the Presidency in 1789 he was given a banquet in the hall.

In 1805 the building was enlarged to its present size, 80 by 100 feet, and an additional story added.

The interior construction, of wood and plaster, was left un-



The main hall as it appeared in 1883. It is practically the same at the present time. The large canvass in the center represents Daniel Webster replying to Hayne in the Senate on January 26, 1830. The central figure on the left is a painting of Peter Faneuil by Sargent.

touched. Although, on this account, danger of a serious fire was quite possible, the building remained intact until remodeled by the city of Boston ninety-three years later.

Present Construction.

In 1898, the building was reconstructed of fire-resistive material. Every care was taken to reproduce the effect of the original structure, with excellent results. The walls were covered with metal lath and plaster. The floors were reconstructed with reinforced concrete and a layer of two inches of concrete was placed under the roof. The wooden stair balusters and treads were replaced by wrought iron and the columns reproduced in steel and cement. As reconstructed, the floors of the hallways are of broken marble laid in cement. The steps on either side of the hall, as well as in the gallery, have steel stringers with wrought iron risers and treads of hard pine. The cupola is an exact reproduction of the original design, in iron, steel and copper. It is unfortunate, however, that the basement seems to have been disregarded; the construction here is largely of wood with wooden floor beams overhead.

Heating.

Faneuil Hall is at present heated by steam supplied by pipes which run underground from a nearby building. This system, as far as it goes, is entirely satisfactory from a fire prevention point of view. The system does not include the basement market stalls. These are heated by gas radiators. In some cases these radiators are placed

Faneuil Hall at the present day. Note the congested district in which it stands. The exposure hazard is severe.

close against wooden partitions and they are often left burning all night unattended. This condition is unsafe and should be remedied.

Occupancy.

The basement is occupied by market dealers for storage of their goods. The refrigerating rooms are cooled by pipes from a storage warehouse nearby, eliminating danger of explosions in refrigerating machinery. Some of the basement rooms are piled with boxes and barrels of foodstuffs. The hazard of this basement is high. The ground floor is occupied by markets used for the sale of meats and dairy products. The main hall covers the second floor with offices for the superintendent and caretakers on the hallway. The top floor is used by the Ancient and Honorable Artillery Company of Massachusetts as a drill hall and museum. Many historic relics are kept there. The company, which was chartered in 1638, has an interesting history. Its quarters were removed to Faneuil Hall in 1746, and have remained there up to the present time.

Fire Protection.

The building is easily accessible to the city fire department. There is, however, no automatic alarm device or auxiliary alarm box, making dependence on either an outside box or a telephone necessary. The upper floors of the building are fairly well supplied with 2½-gallon soda-acid extinguishers. There is no other first aid equipment in the building nor is there a sprinkler system. While it might be impracticable to install sprinklers in the basement because of the many subdividing walls and refrigerator rooms there should at least be an adequate complement of small extinguishers there. The gas

radiators should be removed and either extensions from the pipes of the main heating system or some other safe heating system provided. These precautions are the very least that should be taken. It would be most advisable, from the standpoint of fire safety, to tear out this basement and rebuild with fire-resistive construction, not allowing any market or other occupancy in it.

Protection against exposure fires in other buildings could be provided by replacement of all windows with wired glass in metal sash and installation of outside sprinklers to form a water curtain. Such protection would not detract from the appearance of the building.

At the present time, there is danger of a false sense of security, because of the excellent general construction of the building. The precautions suggested above would make Faneuil Hall reasonably safe against fire.

Note: The historical matter for this article is largely from "Faneuil Hall and Faneuil Hall Market," by Abram English Brown. The photographs were obtained through the courtesy of Mr. Murphy of Faneuil Hall.

The Snowball Hazard.

WEST BRIDGEWATER, MASS.—John L. Hayward was enjoying a smoke at the door of his barn. A boy in a passing automobile heaved a snowball. It knocked the pipe out of Hayward's mouth. While Hayward pursued the boy the burning tobacco from the fractured dudeen set fire to the hay. Barn and dairy destroyed. Loss, $2,200.—*New York Journal of Commerce.*

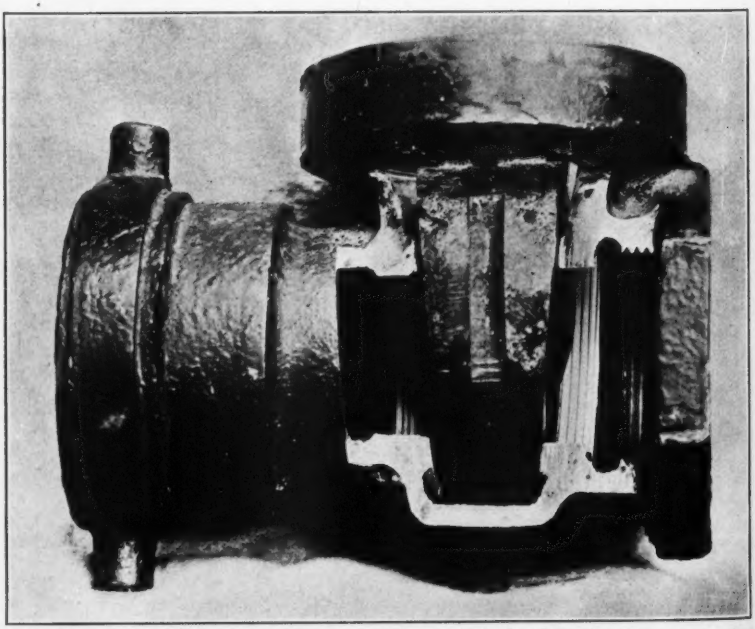
Gate Valve Face Bulged by Freezing.

By H. L. Miner.

(Member N. F. P. A.)

Exposed gate valves are frequently injured or rendered inoperative due to freezing. When this occurs it is usually very noticeable, due to bulged or split valve bonnet or cracked valve body. Recently, however, the Fire Protection Division of the du Pont Company had brought to their attention a number of hose gate valves which to all external appearances were in good operative condition. The effects of the freezing were confined to the valve seat, the surfaces being bulged inside of seat rings which prevented the gate from being raised. Investigation disclosed the fact that this condition has occurred both with the solid wedge type gate valve and with the split wedge type.

In closing the valve under pressure, the hollow space inside of the gate became filled with water. When the hydrant was shut off the water in the hydrant barrel and hose connections drained out through drip open-



The faces of the disc of a solid type wedge gate bulged by freezing so as to prevent valve opening beyond position shown.

ing, but the water in the valve gate was trapped due to gate being in closed position. Upon freezing, the expansion of the water bulged both faces of the gate, as indicated by the accompanying illustration.

Injury of this nature is very difficult to detect unless the valve is opened and closed, for to all outward appearances the valve is in good condition. Unless guarded against, it may result in important hose lines being useless at time of fire. Several methods have been suggested for overcoming this undesirable feature. One method is to install a small pet-cock in the bottom of the valve so that it connects with space between the two faces. Another is to drill a small opening through one face of the valve, selecting side away from the source of water. One fire inspector states that he always partially opens valves after they have been used and allows the water to drain out of gate before closing it. The writer favors the pet-cock installed in the bottom of the valve body so that it will drain the space between the two surfaces of the gate.

Personal Liability in Newark.

A Recent Court Decision.

By C. Albert Gasser.

(Member N. F. P. A.)

The decision handed down by the Court of Common Pleas, in and for the County of Essex in the State of New Jersey, imposing a fine of one thousand dollars on Mrs. Bertha Weiss is of interest to all those having to do with fire prevention. Mrs. Weiss was charged with manslaughter after two aged women were burned to death in a tenement house owned by the defendant. Following is a brief summary of the case:

At 233 West Kinney Street in Newark is a three-story frame building which was erected about 1870. At that time there was a store on the first floor and a dwelling for one family on the second floor and a dwelling for one family on the third floor. There was a hallway and stairs from the street front to the third floor and there was a rear porch stairway to the upper floors from a back yard.

In the course of time the stairway from the street to the second floor was removed to make more room for the store on the first floor and an addition was built in the rear to make the store larger. A stairway from the street in the frame dwelling adjoining on the east was used for both houses by cutting a doorway between the two houses on the second floor but nothing was done to replace the rear porch stairway. A second floor addition or extension was also built so that the rear presented a three-terrace effect by reason of the irregular extensions.

Changes in ownership followed and changes in tenancy. About a year ago inspectors of the New Jersey State Tenement House Commission discovered that the third floor which consisted of only four rooms had

been sublet so that one man occupied the two rear rooms and two women occupied the two front rooms. All these rooms communicated to the stairwell but the door between the front and rear rooms was locked on the one side by a screw hook and eye and on the other side by an ordinary lock and also a bolt.

So the Tenement House Commission served a notice on the owner, Mrs. Bertha Weiss, who lived with her family on the second floor, that she should have to equip the building with fire escapes. This was in July, 1920. A second notice was sent on May 16, 1921. To these notices no attention was paid.

On Monday morning, July 11, 1921, there was an alarm of fire at 3.20 o'clock. On their way to the place the firemen saw flames shooting through the roof of the building. They worked with their usual vigor and extinguished the fire. The stairway from the second to the third floor had been completely burned away so they got into the third floor by means of ladders and in one of the front rooms they found the bodies of two aged women who had been suffocated and then burned to death. There was absolutely no way for them to escape—the stairway was burned away and the door to the rear rooms was locked on both sides. One of the women had been seen at a window before the arrival of the firemen. The man who lived in the rear rooms was awakened by the shouts of the people on the street. He climbed through a window to the rear open porch and from there jumped to the roof of the extensions below. Although he was a cripple and an invalid, he escaped injury. Had the door to the rear rooms been unlocked it is more than probable that the two women could have made their way to the rear open porch and been rescued by the firemen.

After the fire there were five investigations and the usual statements and explanations were made. The Public Prosecutor was appealed to and after careful examination of the statutes it was decided to prefer charges of manslaughter against the owner on each of two counts, naming one of the women burned to death in each complaint. On July 18, the charges were filed and on the following day Mrs. Weiss was arrested and released in bail.

On October 29, 1921, the indictment was presented by the September Term, 1921, Grand Jury. The defendant pleaded Not Guilty and was bailed in $2500, for appearance for trial on November 14. The trial was postponed to January 9, 1922, thence to January 16. At that time the defendant retracted her plea of Not Guilty and pleaded Non Vult*. Sentence was postponed to February 6, 1922. On that date the fine of one thousand dollars was imposed. The Court stressed the fact that the defendant was a woman, well advanced in years; that a jail sentence would be of benefit to no one, that she had pleaded Non Vult, and that she had since complied with the law and that a fine would serve the ends of justice.

The significance of the case is in the fact that an indictment was secured and the offender was punished for failure to comply with an existing law. It would seem probable that this decision will form a basis for similar action wherever willful neglect causes loss of life from fire.

*A plea by the defendant in a criminal prosecution, which, without admitting guilt, subjects him to a judgment of conviction as in a case of a plea of guilty, but does not preclude him from denying the truth of the charges in a collateral proceeding.

The Story of a Fire.

It was the vacation season and an automobile carrying a party of tourists stopped on a road that wound through a magnificent stand of Douglas fir in eastern Washington. The travelers sat in rapturous admiration of the quiet forest scene and rhapsodized over the great trees that columned their majestic beauty as far as the eye could see. One of the men of the party lit a contemplative cigarette and tossed the match to the side of the road.

Half an hour later an airplane patrol flying high above the mountain range saw yellowish smoke ballooning over the tree tops. He moved his control and turned in that direction. Upon the chart in the machine before him he located the fire approximately, then returned quickly to a mountain fire station 10 miles away. By wireless telephone he called to the man in the station:

"Fire, twenty-six thirty-one, southwest."

Back came the instant reply:

"Twenty-six thirty-one. Have it."

Soon a dozen telephones over a hundred mile area were buzzing with the call "twenty-six thirty-one" From his aerial perch the flying patrol could discern automobiles on many roads hurrying to the fire. Along many trails crews of men on foot seemed to make exasperatingly slow progress in the same direction. In the meantime the smoke grew into an enormous yellowish white fog that screened the surrounding forests, and in the aerial patrol's ears came the roar of conflagration punctuated by the booming of falling trees. Where the wind blew the smoke away the patrol could see the flames leaping from tree top to tree top.

After what seemed an interminable wait the patrol noted various gangs of men at work. They were combating that most terrifying, most ungovernable and dangerous of all rebellious elements—the forest fire. For a day and a night and another day the battle waged. Grimy men, black as the charred trunks around them, worn to the last stages of exhaustion, fought on—cutting away under-brush, dynamiting logs and trees, beating out the slinking fringes of advancing ground fire, shouting one to another above the cracking inferno of heat and smoke, panting like hunted animals around the water barrels where they slaked their thirst with the luke-warm liquid, but gaining, almost imperceptibly at first, yet gradually with greater certainty as the weary hours dragged on. And amid the confusion and crash of falling timber the ranger and his foremen generaled the battle.

Several days later a wide, barren scar lay upon the mountainside, still smouldering in places where the black splinters of the charred stumps pointed like accusing fingers, and still sending out masses of yellowish white smoke. The scar covered hundreds of acres and it would continue to smoulder and smoke for weeks, while all about in the adjacent woods were fire guards constantly vigilant to see that the enemy did not creep out and strike again.

And far away the automobile tourist journeyed carefree and utterly unconcerned. At a sawmill they stopped for a few minutes to watch the logs in slow procession from the pond to the band saws. "What a shame," exclaimed the man with the cigarette. in a burst of sentimental revolt, "what a shame to cut down these beautiful trees."

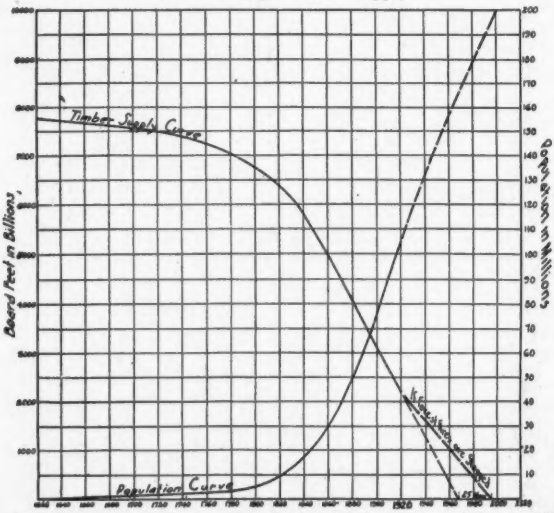
Timber Conservation.

The Development of Town Forests in Massachusetts.*

NOTE:—By Chapter 45, Sections 19 to 24 inclusive, of the General Laws of Massachusetts, a town may by a two-thirds vote at an annual meeting, and a city by a two-thirds vote of the council, determine to take or purchase lands for the culture of forest trees. Land held for water supply purposes in other cities or towns may also be converted into public domain. The town forest may be placed under the supervision of the State Forester, who shall make regulations for the care and use of such land. Buildings may be erected on the town forest for public instruction and recreation, and these may be leased by the city or town.

Of the forty-eight States, thirty-three consume vastly more timber than they produce, and Massachusetts is one of them. About five-sixths of the original timber in this country is gone, and according to the best available information the supply will be exhausted in fifty years. One hundred years ago we had 10,000,000 people and over 6000 billion board feet of timber. We are now started on another century with over ten times as many people and less than one-third as much timber.

Our Vanishing Timber Supply.



Population Curve made from U. S. Census Reports. Timber Supply and Forest Fire Data from the Capper Report Compiled by the U. S. Forest Service, and other Sources.

Massachusetts now imports about eighty per cent of the wood it uses, while within the memory of men still living she was one of the large timber exporting states. In other words, the lumber used in four out of every five houses built in the state today comes from other states, mainly

*Cuts and information by courtesy of Massachusetts Forestry Association.

from the South and the Pacific Coast, and the high cost of lumber is reflected in higher rents.

Foresters and lumbermen are agreed that within twenty years the bulk of the lumber used in the East will have to be brought from the Pacific Coast, and the cost for transportation alone from there is more than it would cost to grow the timber at home. In Massachusetts there are 1,000,000 acres which would grow much of the needed timber if set to work, but a fifth of this state might just as well be a desert as in its present condition. It yields about ten cents an acre on the average yearly in taxes, and nothing for the owner. It costs more to protect it than the income from it in taxes. Planted to trees of commercial species, and managed on forestry principles, this land will yield about $5.00 per acre per year (not realized of course until the crop is harvested or the land sold) besides creating an industry when the first crop is produced, which will furnish permanent work for 20,000 men.

Forest fires are sweeping over 10,000,000 acres—an area twice the size of Massachusetts—annually, in this country, causing a loss of over $20,000,000 in standing timber and as much more in soil, humus and young growth. Imported and native insects and fungi are also destroying millions of dollars in timber annually, and at the same time increasing the risk and cost of producing timber. It requires from fifty to one hundred years to grow a crop of timber—depending on the species—and for that reason reforestation is not an attractive investment to the average individual. He must not only run the risk of losing his initial investment, interest and taxes, from fire, insects, disease or other causes, but he can hardly hope to reap the profits unless he can realize on the sale of the land and the growing crop.

As a nation we are facing our first serious problem created by the shortage of a natural resource, and it must be solved and solved comparatively quickly if our children and grandchildren are to enjoy the conveniences and comforts which we have derived from an abundant supply of timber. A bountiful timber supply has been one of the most important factors in our wonderful industrial development. *We have reaped where we did not sow.* But, we have reached the turning point, and must now follow the course of older nations who have been forced to grow their timber instead of finding it ready to cut, as we have done for the past three hundred years. All countries faced with a timber shortage in the past have found that the production of the forests is a function of government. It is a public duty to supply a public need which cannot be supplied by private initiative. Timber must be had to supply our industries. Therefore, if it is not produced by the individual, it must be produced by the public, even at a financial loss on the production operations. Our wood supply in the future must come largely from national, state, county and municipal forests. In Massachusetts the town is the political unit which has begun to play this important rôle in the production of a future timber supply.

Town Forests in Europe.

The idea of towns owning commercial forests is not new. Some such forests in Europe are several hundred years old, and the best proof

Town Forest of Baden-Baden in the Black Forest Showing Method of Taking Out the Timber.

of their success is the fact that the cities and towns are still buying more forest lands for that purpose. Cities and towns in practically every country of Europe own town forests. That these forests are profitable to the towns can best be shown by a few examples. The average annual net profit per acre for ten of such forests before the war in Switzerland and Germany was $6.20. In practically every case the land was too steep or otherwise unfit for agriculture, except for small patches within the forests that were tilled by peasants. The town forest of Forbach in the Black Forest region is one of the best examples, with an annual net profit of $12.14 per acre. The forest covers an area of 1482 acres and the population of the town was 1900 in 1913. In many places certain citizens whose ancestors helped to establish the forest received each year a part of the profits, and in other places they received free firewood. A number of citizens in Forbach received $36.00 each, annually, from the profits obtained from the town forest. The people of many of the small villages which own large forests had no taxes to pay. *Imagine being handed a check instead of a tax bill!*

The city of Zurich, Switzerland, has a very famous forest, known as the Sihlwald. The topography is mountainous, and the forest is very expensive to maintain, but even with the establishment of old-age pensions, accident and sickness insurance for employees, the forest still nets from $6.00 to $7.20 an acre yearly. It is one of the most highly developed forests in Europe, being about 1000 years old, and the cutting rotation for all species is 110 years. The forest gives permanent employment to one man for every thirty-three acres and many temporary employees are added to the force in winter and during seasons of unemployment.

It is interesting to note that the prices paid for bare land for town forests ranged from $50.00 to $80.00 per acre, and where the land contained forest growth the price varied from $120.00 to $240.00 per acre. It is evident that those cities and towns receive more benefits from their town forests than the money profits. In the small outlying places wood-using industries are located which are dependent upon the products of the

Fitchburg's Town Forest

This is said to be the first legally established town forest in the United States. White pine about forty years old.

forests. The small farmers practise intensive farming on their patches of land in the summer and go into the town forest as laborers in the

winter. All the old-established forests are on a sustained yield basis so that they know just how much timber they can cut yearly for an indefinite period. This fact tends to stabilize the small industries, which can always count on a steady and permanent supply of raw material.

While we cannot make comparisons between this country and Europe generally, because of different standards of labor and of living, it would seem that if the cities and towns of the European countries can afford to pay $80.00 per acre for bare land for town forests, we would not be

Walpole Town Forest. Small Trees Planted by School Children in 1916.

making a mistake here to buy lands for a similar purpose at $5.00 an acre, the amount at which much of our idle land is assessed.

The town forest of Europe really fills the place of our wild parks in this country. But, the difference lies in the fact that they practise forestry on such lands and make them pay for their maintenance besides returning a money profit. With us such areas have to be supported by taxation. The people go into the town forests by the hundreds on Sundays and holidays. Small inns are established in the beauty spots where their favorite refreshments are to be had in abundance. Game, especially deer, is plentiful. The hunting seasons are very short and the licenses expensive. Bird sanctuaries are maintained.

The town forest is free from local politics. Usually the state appoints the forester, whose decisions as to methods of management are final. He is paid by the town and is one of the leading citizens. The town forest is one of the most popular local institutions in Europe.

Town Forests in Massachusetts.

Fitchburg, Massachusetts, holds the unchallenged distinction, so far as we know, of having established under a state law the first town forest

in the United States. It is composed of four parcels, the smallest being ten acres in area, the largest forty-seven acres. The aggregate area is one hundred and nine acres. This forest was created on December 29, 1914.

About half of the land is covered with natural growth, both hardwood and pine. The natural growth pine is approaching maturity as the picture shows. The remainder of the area is being planted to pines and the whole tract is being handled in an efficient manner by the city forester.

One thing to note about the Fitchburg forest is that it is not all in one tract, which shows that very small areas can be obtained for this purpose and still be profitably managed. In fact, a distribution of the areas reduces the fire risk.

The town of Walpole is the second in Massachusetts to secure a town forest. It was very fortunate in having a public-spirited citizen who presented it with one hundred and fifty acres of land near the official center of the town. Forty acres were planted in one year. The school children planted the first acre on Arbor Day, 1916, and the pines planted by them are shown in the foreground of the picture, page 334. The forest has also been made a bird preserve. Fire prevention has been an important feature of the work already done and with the construction of roads and other facilities it is destined to be one of the finest recreation areas in the state.

Brookline, Mass., has a watershed of three hundred and fifty acres, which is known as its town forest. The town has planted several thousand pines and the area will some day be covered with a valuable forest. There is no reason why the watersheds of cities and towns should not be producing commercial forests which, when mature, can be cut conservatively without contamination to the water supply or injury to the forest floor. One purpose of the Massachusetts town forest act was to encourage such treatment of the watersheds of cities and towns, and in fact many places are already making progress in covering those areas with growth of commercial value.

Second growth white pine about fifty years old in the Petersham Town Forest. This land was farmed just before the Civil War.

Petersham, like many other Massachusetts towns, owned a poor farm. It contained about two hundred acres and most of it was covered with forests in various stages of development. Some twenty years ago the almshouse was closed, but the farm still remained town property. Little attention was given to it until some one proposed that the farm be sold. Then a committee was appointed and instructed to investigate the matter.

That committee found the greater part of the farm covered with splendid stands of white pine, some of it merchantable, and that an increment of not less than seventy-five thousand board feet was accruing each year. The committee therefore recommended that the property be held as a town forest and that a sale of

timber be made immediately. The town meeting voted to instruct the selectmen to carry out the recommendations of the committee's report. Accordingly, an area of about thirteen acres was marked off and the timber sold at auction for $5200, or $400 an acre. "While this sum is at least a third of what the whole property might bring today, it is hardly a tenth of the total returns which may be got from the forest during the next forty years" in the judgment of Director Richard T. Fisher of the Harvard Forest and a member of the committee.

There are ninety other towns in Massachusetts which own poor farms, each containing over twenty-five acres of forest land, with an average of eighty-nine acres. Every one of these towns could profitably follow the example of Petersham.

Town Forests and Farming.

One hundred and thirty-eight towns in Massachusetts have fewer inhabitants today than they had fifty years ago, and on the average the loss has been twenty-five per cent. Although the population of the State as a whole is two and one-half times as great as it was in 1870, the fact remains that besides this large proportion of towns that has actually lost in population, a large number of others have little more than held their own.

The causes for this exodus from the small outlying towns are many, but the time they were most prosperous was when they were still well supplied with timber, which kept the sawmills and wood-working establishments going. These industries held many people in the towns and created a ready market for farm produce. With the disappearance of the timber the sawmills abandoned the towns, as did many of the small wood-working establishments, and this reduction in population was an important factor in bringing about the abandonment of farms.

It is acknowledged even by the leading agriculturalists that many of these abandoned farms cannot be utilized profitably for the growing of crops and it therefore would seem that the best possible use for them is the production of timber.

Town Forests Established on Lands Not Suited for Agriculture Would Benefit the Farmer.

The idle land in any town which is generally listed as sprout or brush land is of little value to the owner, produces but a few cents per acre in taxes and does not furnish employment to anyone. If this land were taken over by the town and the weed trees replaced with trees of commercial species, like white pine, the land would furnish employment to some persons almost from the beginning in preparing it for planting and in doing the planting. Much of this work would be done either in the winter or at mud time on the farm, and would furnish employment to the farmers and farm laborers. After the young trees were planted there would be work in the building of roads and fire lines and after a few years the thinning of the plantations would begin. When the trees neared maturity, if the forest were properly managed, there would be some work every year for men and teams. This would enable the farmers to employ their teams, which would otherwise be idle in winter, and to find

Abandoned Farm.

Hundreds of farm buildings like this have been abandoned in Massachusetts. Orchards, fences and other farm facilities have gone to ruin. Some of these farms may be reclaimed, but most of them are fit only for tree growth and should be used for town forests.

work for their farm hands. While the land devoted to town forests would be taken out of taxation the loss would hardly be noticeable, and once it was set to growing trees, it would be producing lumber, the net profit from which when harvested would average about $5.00 per acre per year, which would help reduce the tax rate.

If the supervision and general management of the town forest were placed under the State Forester, as it should be in most cases, the farmers would benefit by having increased fire protection to their own wood lots, because when money is once invested, either by the state or the town in the growing of trees, more attention is given by the public to fire prevention and other protective measures. Furthermore, the representative of the state forester would be constantly available to advise the farmers in the treatment of their own wood lots. In many Massachusetts towns there are today small wood-using industries which are having difficulty in obtaining raw material locally. The production of timber in town forests would help to retain those industries and even bring more into the town, which in turn would increase the population and enlarge the market for the farmers' produce.

Town Forests and Local Industries.

The days of the tramp sawmill in Massachusetts are numbered. Some of them are already having a hard existence. The lots cut over are smaller, the moves more frequent and the distances greater. Transportation of logs by trucks enables the stationary mill to serve efficiently a much larger territory than ever before. The cost of moving is eliminated, the machinery can be properly housed, the maintenance is less expensive and the employees are more permanent. In fact, there are many

Planting young pines on the Myles Standish State Forest, Plymouth County. Thousands of acres of idle land like this are to be found in Massachusetts.

examples in the state where the permanent sawmill or wood-using factory has been located in one place for generations. Those mills have practically reached a capacity where the output equals the annual growth in the district served. When this condition becomes general forestry can then be practised on a business basis which will insure a local supply of raw material to keep those home industries going. Instead of floating organizations coming into a town and cutting a lot here and there often with outside help, this work will be done by the people who make their homes in the towns.

The sooner that condition is reached generally, the better it will be for the towns. It will mean more permanent residents in the small places and the result will be beneficial to every kind of business located there. It is simply a problem of making the natural resources of the community support the maximum number of families, and the creation of town forests will be a long step toward accomplishing that result.

Town Forests and Unemployment.

While unemployment in the small towns is not so common as in the larger centers, yet there are many towns and cities where idle land is available and where unemployment is a common thing. In such places the town forest is a good outlet for such surplus labor. Logging, thinning, building of fire lines, roads and other facilities can be done in the winter almost as well as at other times.

Town Forests and Recreation.

The tension of our modern civilization calls for wholesome recreation and no city or town is wise which does not provide amply for play in the open. A wild park has more attractions to the young than the neatly kept public garden cluttered with "keep-off-the-grass" signs. The

Which?

picture below was taken in a national forest in the West, where a very large per cent of the population spend their vacations camping, fishing and tramping through the forests. A town forest makes an ideal place for picnics and camping parties and in these days of "no trespass" signs such areas give an opportunity to the boy and girl scouts to enjoy the freedom of the forest near at hand.

Recreation Like This Is Good Health Insurance.

The custom of going camping with an automobile is fast becoming a habit with people in New England as it is in the West. It is a splendid custom, but the public must recognize the need of providing camp grounds for this purpose.

Town Forests and the Conservation of Water.

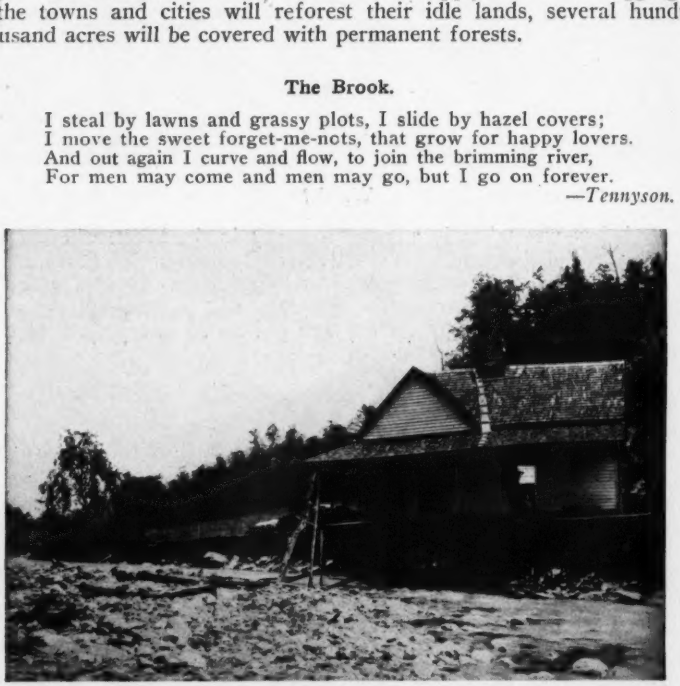
There are very few mountains or bare steep slopes in Massachusetts. However, it has been proved even in this state that the cutting of the forests at the headwaters of small streams affected them adversely. Massachusetts cannot afford to waste water because it is one of her chief sources of power. One-seventh of the motive force of Massachusetts comes from falling water and much of her water power is still unutilized.

The forest is the greatest of all natural reservoirs, and all streams should be kept protected with forests on the watersheds. One town forest may not have much influence on the water supply, but in the aggregate, if the towns and cities will reforest their idle lands, several hundred thousand acres will be covered with permanent forests.

The Brook.

I steal by lawns and grassy plots, I slide by hazel covers;
I move the sweet forget-me-nots, that grow for happy lovers.
And out again I curve and flow, to join the brimming river,
For men may come and men may go, but I go on forever.

—*Tennyson.*



What He Might Have Written Had He Seen This Brook!

The forest once my source is gone, I raze the hazel covers;
I sweep the dwellings from my banks, once filled with happy lovers.
And now and then I rave and roar, just like a brimming river,
For though I still may come and go, I'll soon be gone forever.

Fire Losses of 1921.

United States and Canada.

From the Journal of Commerce.

The fire loss record of the country for the year 1921 has been exceeded only once and that in 1906, the year of the great San Francisco conflagration. The past year's losses by fires in the United States and Canada as compiled from the daily records of *The Journal of Commerce* reached a total of $332,654,950. This is even greater than the 1920 total of $330,853,925, when higher valuations on property of all kinds helped to swell the figures. The fire losses came in from all parts of the country and, while the year was free from any general conflagration, the steady flow of losses built up a total that practically has no equal in past records.

The causes which are responsible for this great waste of the nation's wealth are many, but chief among them in last year's record are carelessness and moral hazard.

The moral hazard feature is a serious one. There were a markedly greater proportion of fires in lines of business which were particularly affected by the depression or price deflation. For instance, in sections of the South where the cotton crop was a failure the fires were exceptionally numerous. In the East and North certain lines of manufactured goods were notably frequent in their appearance in the fire loss records.

Effect of Business Depression.

The wave of excessive fire losses started in September, 1920, when business depression became pronounced, and has continued in force ever since, as may be seen from the following table of fire losses by months for the past three years:

	1919	1920	1921	1922
January	$ 29,446,325	$ 37,912,750	$ 35,319,950	$ 38,633,000
February	26,891,950	26,631,500	25,888,850	29,304,300
March	22,201,900	27,597,700	28,581,100	
April	15,484,750	22,108,750	22,178,900	
May	16,516,300	25,440,300	23,956,800	
June	20,475,750	25,743,900	29,000,700	
July	20,198,600	25,135,825	33,355,750	
August	24,526,000	17,930,800	25,829,000	
September	29,083,500	25,630,050	26,502,400	
October	13,358,400	28,331,100	27,955,350	
November	23,450,800	28,093,350	26,178,600	
December	27,366,500	41,197,600	28,907,550	
Year	$269,000,775	$330,853,925	$332,654,950	$67,937,300

That 1922 is continuing and even promising to surpass last year's tremendous losses can be seen from the figures for January and February appearing in the table above. The losses for these months aggregate

$67,967,300 as compared with $61,208,800 for the same months of 1921.

Aggregate Loss for Forty-three Years Is $7,695,475,695.

The 1921 fire losses bring the total fire waste of the United States and Canada during the past forty-three years up to the remarkable sum of $7,695,475,695, or an average of $178,964,551. These losses, however, when considered in relation to present-day burning ratios, it should be remembered, are based upon steadily increasing property values exposed to fire hazards. For instance, the fire losses of $164,347,450 in 1901 resulted in as high a burning ratio to the aggregate value of all property in that year as the $332,654,950 loss of 1921 is to present valuations. The following table gives the fire loss record by years since 1879:

1921	$332,654,950	1899	$136,773,200
1920	330,853,925	1898	119,650,500
1919	269,000,775	1897	110,319,650
1918	317,014,385	1896	115,655,500
1917	267,273,140	1895	129,835,700
1916	231,442,995	1894	128,246,400
1915	182,836,200	1893	156,445,875
1914	235,591,350	1892	151,516,000
1913	224,728,350	1891	143,764,000
1912	225,320,900	1890	106,893,700
1911	234,337,250	1889	123,046,800
1910	234,470,650	1888	110,885,600
1909	203,649,200	1887	120,283,000
1908	238,562,250	1886	104,924,700
1907	215,671,250	1885	102,818,700
1906	459,710,000	1884	110,108,600
1905	175,193,800	1883	110,149,000
1904	252,554,050	1882	84,505,000
1903	156,195,700	1881	81,280,000
1902	149,260,850	1880	74,643,400
1901	164,347,450	1879	77,703,700
1900	163,362,250		
Total for 43 years			$7,695,475,695

The fires of 1921, which, in each instance, resulted in an estimated property loss of $10,000 or over, were greater in number than in 1920 by over 10 per cent. Last year there were 3,855 fires reported where the loss reached or exceeded $10,000 as compared with 3,457 such fires in 1920, 2,904 in 1919 and 2,943 in 1918.

Large Loss Fires in 1921.

While there were no large conflagrations or individual losses over $5,000,000 during the year the numerous losses from a few hundred thousand dollars up to the million-dollar mark served to make up the tremendous total. There were 680 fires reported with losses over $100,000. Following is the list of fires showing losses of $1,000,000 or over:

LOCATION	DESCRIPTION	AMOUNT
Charleston, W. Va.	Capitol Bldg.	$1,250,000
New Haven, Conn.	Department Store	1,000,000
Worcester, Mass.	Business District	1,500,000
Buffalo, N. Y.	Airplane Plant	1,000,000
Baltimore, Md.	Steamship	1,000,000
Santa Barbara, Colo.	Hotel	1,500,000

LOCATION	DESCRIPTION	AMOUNT
Huttig, Ark.	Saw Mill	1,200,000
Toronto, Ont.	Military Storehouse	1,000,000
Jacksonville, Fla.	Warehouse	1,500,000
McKeesport, Pa.	Tin Plate Mill	2,000,000
Salt Lake City, Utah	Oil Refinery	1,000,000
Tulsa, Okla.	Dwellings	1,500,000
Beaumont, Texas	Oil Tank	1,000,000
Chicago, Ill.	Warehouse	1,000,000
Elmira, Colo.	Ranch Buildings	1,000,000
Whiting, Ind.	Oil Refinery	2,000,000
Almea, Ont.	Conflagration	1,250,000
Smithfield, Va.	Factories and Piers	1,000,000
Beaumont, Texas	Oil Refinery	1,000,000
Weehawken, N. J.	Docks	1,000,000
Dallas, Texas	Film Exchange	1,000,000

Reduction in British Losses in 1921.

The fire losses in the United Kingdom show a substantial reduction from those of 1920 and a really large reduction from those of 1919. Monthly losses for the past three years are given below:

	1921	1920	1919
January	£370,000	£303,000	£1,146,700
February	350,000	694,000	485,400
March	425,000	506,500	421,100
April	643,000	479,500	176,950
May	936,000	1,120,000	506,700
June	780,000	806,000	4,576,200
July	820,000	619,000	576,800
August	1,070,000	561,000	366,700
September	750,000	940,000	445,000
October	620,000	1,155,000	498,000
November	475,000	500,000	378,000
December	525,000	805,000	440,000
Totals	£7,764,000	£8,489,000	£10,017,550

Canadian Fire Waste, 1921.

According to a bulletin of the Dominion Fire Prevention Association there was a striking increase in the Canadian fire waste of last year over that of the three years previous, based upon reports made to the Dominion fire commissioner. During the year 1921, the 25,916 fires reported occasioned property damage amounting to $45,015,930, exclusive of the incalculable loss arising from forest fires. In comparison with the years 1920, 1919 and 1918, when the losses were $28,745,590, $25,361,240 and $33,817,050 respectively, the record for 1921 shows so substantial an increase as to tend to confirm the general belief that fires and trade depression go together. Of the total loss, approximately $34,000,000 or 75 per cent was covered by insurance. On the basis of population, the loss in Canada amounted to $5.22 per capita as compared with $0.90 per capita in Great Britain, where fire losses in 1921 only amounted to $36,400,000. By Provinces, the distribution of the fire loss in Canada was as follows: Alberta, $2,875,000 or $4.95 per capita; British Columbia, $3,050,000 or $5.82 per capita; Manitoba, $2,864,000 or $4.67 per capita; New Brunswick, $2,735,982 or $7.02 per capita; Nova Scotia, $3,177,000 or $6.06 per capita; Ontario, $15,444,817 or $5.28 per capita; Prince Edward Island, $216,478 or $2.44 per capita; Quebec, $10,897,653 or $4.64 per capita, and Saskatchewan, $3,755,000 or $4.93 per capita. As reported by municipal officials, the losses in cities having populations of more than 10,000 amounted to $13,616,951 or $4.29 per capita; in towns of from 1,000 to 10,000 population, $6,184,085 or $7.32 per capita, and in villages and rural districts, $25,214,894 or $5.31 per capita. In places having municipal fire protection systems the loss was $4.90 per capita, and in unprotected places, $5.25 per capita. There were 59 fires where the loss exceeded $100,000, 46 with a loss of from $50,000 to $100,000, 261 with a loss of from $10,000 to $50,000, 3,992 with a loss of from $1,000 to $10,000, and 21,558 with a loss of less than $1,000. The 59 larger fires entailed an aggregate loss of $15,824,801 and the 21,558 smaller fires an aggregate loss of $4,644,817. Classified according to the character of the property involved, the more destructive fires occurred as follows: 49 in industrial property with a loss of $8,188,200; 32 in mercantile property with a loss of $5,659,000; 9 in institutional property with a loss of $1,948,561, and 15 in miscellaneous property with a loss of $4,301,465.

In Five Years — $1,672,722,677.

Fire Loss figures for 1916 to 1920, inclusive, as compiled by the Actuarial Bureau of the National Board of Fire Underwriters. (Member N. F. P. A.)

An analysis of fire losses in the United States during the five years ended with 1920, just completed by the Actuarial Bureau of the National Board of Fire Underwriters, presents an astounding picture of destruction, the aggregate losses for the period amounting to $1,338,178,142.

This is the actual record compiled from 3,302,930 Adjusters' Loss Reports. In order to ascertain the full amount of loss suffered by fire, 25% should be added as a conservative estimate of the damage wrought by unreported fires and those in uninsured property. This addition brings the grand total to $1,672,722,677. And most of the loss was preventable!

If the total amount lost in the five years had been used constructively instead of being literally thrown away, the sum would have built 334,540 dwellings, costing on the average $5,000 each, thus supplying homes for 1,672,720 people. (*This exceeds the total population of Connecticut, Nevada and Wyoming.*)

Or it would have constructed 16,727 schoolhouses, costing $100,000 apiece.

It is surprising to find, in analyzing the figures, that during the five years under consideration the hazard of *Matches-Smoking* caused the greatest individual amount of damage, whereas during the five years ended with 1919 carelessly used *Electricity* held first place.

In the present compilation, however, the total for *Matches-Smoking* is $90,271,334 as compared with $85,735,168 for *Electricity*. The third largest loss, namely $63,324,071, was due to fires caused by *Stoves, Furnaces, Boilers and Their Pipes,* while *Defective Chimneys and Flues* came next with an aggregate of $61,975,786.

Following in order among the larger fire causes are spontaneous combustion ($61,192,591), lightning ($48,563,955), sparks on roofs ($41,667,246), and sparks from machinery ($39,673,406).

New York leads all other states in total damage from fire for the five-year period. Its aggregate loss was $164,425,819. Pennsylvania was second with $96,779,559, Illinois third with $87,967,615, New Jersey fourth with $69,676,018 and Ohio fifth with $63,101,967. Other large loss states were Massachusetts, California, Michigan and Texas.

An interesting comparison of the tremendous five-year total can be

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NOTE: This data was published by the National Board of Fire Underwriters in *Safeguarding America Against Fire* for January, 1922. This publication is mailed regularly to N. F. P. A. members, who should have received the January issue. (New members or those who have recently changed addresses may not have received it.) The data is felt to be of such great value that this partial summary is reprinted in the QUARTERLY, that it may be included in the permanent records of the N. F. P. A.

Fire Losses by States, 1916-1920, Inclusive.

State	Five Year Loss	Average Yearly Loss
Alabama	$18,542,225	$ 3,708,445
Arizona	5,003,184	1,000,636
Arkansas	15,585,704	3,117,140
California	54,213,871	10,842,774
Colorado	7,887,778	1,577,555
Connecticut	17,070,539	3,414,107
Delaware	3,094,913	618,982
District of Columbia	1,901,321	380,264
Florida	11,305,134	2,261,026
Georgia	37,725,926	7,545,185
Idaho	5,763,083	1,152,616
Illinois	87,967,615	17,593,523
Indiana	32,962,624	6,592,524
Iowa	31,790,143	6,358,028
Kansas	17,322,325	3,464,465
Kentucky	21,867,315	4,373,463
Louisiana	19,183,348	3,836,669
Maine	13,353,606	2,670,721
Maryland	21,150,460	4,230,092
Massachusetts	57,671,065	11,534,213
Michigan	53,102,397	10,620,479
Minnesota	41,874,976	8,374,995
Mississippi	15,687,636	3,137,527
Missouri	40,146,699	8,029,339
Montana	10,685,139	2,137,027
Nebraska	15,484,641	3,096,928
Nevada	1,377,169	275,433
New Hampshire	7,746,444	1,549,288
New Jersey	69,676,018	13,935,203
New Mexico	2,224,399	444,879
New York	164,425,819	32,885,163
North Carolina	18,363,454	3,672,690
North Dakota	9,952,172	1,990,434
Ohio	63,101,967	12,620,393
Oklahoma	20,742,283	4,148,456
Oregon	10,395,286	2,079,057
Pennsylvania	96,779,559	19,355,911
Rhode Island	9,624,381	1,924,876
South Carolina	12,532,308	2,506,461
South Dakota	7,134,646	1,426,929
Tennessee	25,205,222	5,041,044
Texas	58,977,411	11,795,482
Utah	3,684,153	736,830
Vermont	4,397,583	879,516
Virginia	26,362,778	5,272,555
Washington	21,825,162	4,365,032
West Virginia	16,261,360	3,252,272
Wisconsin	26,911,724	5,382,344
Wyoming	2,133,177	426,635
Total, United States	$1,338,178,142	$267,635,628

Fire Losses by Causes, 1916-1920, Inclusive.

STRICTLY PREVENTABLE CAUSES.

Cause	Five Year Loss	Average Yearly Loss
Defective Chimneys and Flues	$61,975,786	$12,395,157
Fireworks, Firecrackers, etc.	1,927,499	385,499
Gas, Natural and Artificial	12,776,382	2,555,276
Hot Ashes and Coals, Open Fires	15,563,630	3,112,726
Ignition of Hot Grease, Oil, Tar, Wax, Asphalt, etc.	6,262,261	1,252,452
Matches—Smoking	90,271,334	18,054,266
Open Lights	16,287,028	3,257,405
Petroleum and Its Products	33,973,457	6,794,691
Rubbish and Litter	3,751,974	750,394
Sparks on Roofs	41,667,246	8,333,449
Steam and Hot Water Pipes	2,066,832	413,366
Stoves, Furnaces, Boilers and their Pipes	63,324,071	12,664,814

PARTLY PREVENTABLE CAUSES.

Electricity	$85,735,168	$17,147,033
Explosions	10,342,225	2,068,445
Exposure (including Conflagrations)	232,888,419	46,577,683
Sparks from Machinery	39,673,406	7,934,681
Incendiarism	16,628,095	3,325,619
Lightning	48,563,955	9,712,791
Miscellaneous Known Causes	25,832,124	5,166,424
Sparks from Combustion	25,051,580	5,010,316
Spontaneous Combustion	61,192,591	12,238,518

UNKNOWN CAUSES.

Probably Largely Preventable	$442,423,079	$88,484,615
Total	$1,338,178,142	$267,635,628

made with certain other financial items. The sum exceeds, for example, the value of the entire gold production of the United States during the nineteen years from 1902 to 1920 inclusive. It equals, in value, 16,727 grams of radium, the costliest of earth's products.

The value of the property consumed surpasses by $1,990,677 the worth of the entire wheat, rye and oats crops of the United States in 1920, and exceeds by $268,327,535 expenditures for the conduct of our public schools during two recent years.

A Special Aisle Sprinkler System.

By I. Osgood, Engineer.

Boston Board of Fire Underwriters.

(Member N. F. P. A.)

Fire protection engineers realize that the aisle line sprinkler system, as installed under present rules, is far from satisfactory in carhouses where various types of cars are stored. Furthermore, very decided objection to the standard system is offered by the Railway Companies and their employees, particularly in operating houses.

A recent equipment in one of the carhouses of the Boston Elevated Railway Company was installed in such a way as to overcome to a large extent the objections raised by the Railway Company, and it is believed that under existing conditions the system gives just as effective protection as the standard system.

From the engineer's point of view the present standard system is faulty for the following reasons:

1. Cars of various widths and heights are used, thus making impossible compliance with the rule as to the position of the aisle line with reference to the cars. In the case at hand the standard track spacing, from centre to centre, is 11′ 10″. The horizontal space occupied by the cars varies from 10′ 9″ over the open folding doors of the one man car, to 7′ 8″ for some of the box cars, or a difference of about 3′. The height from top of rail to top of window glass varies from 9′ 2″ in the semi-convertible type, to 7′ 9″ in the one man type, or a difference of 17″.

The impossibility of installing a system to comply with the rules under these conditions is evident, and it follows, therefore, that the system is not at all certain to accomplish its purpose of extinguishing a fire in the car.

2. At best the aisle sprinkler system has but little sensitiveness, as there is usually no opportunity for heat to bank around the sprinklers.

3. Having no protection against water from above, it is quite likely that aisle sprinklers may be made inoperative if roof sprinklers open first.

4. The likelihood that roof sprinklers will open first is considerably increased by structural features of modern cars, viz.: permanently open ventilators in roof or monitor; roofs of very light material, and open trolley rope slots in roofs of center entrance and articulated cars.

Some of the objections to the standard system made by the railway engineers and employees are as follows:

1. The piping system, particularly if two lines between tracks are required, interferes greatly with the usual car cleaning, inspection and repair work, such as window washing, inspection and repair of door operating mechanism and signs.

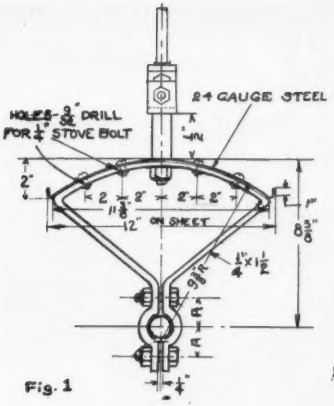


Fig. 1

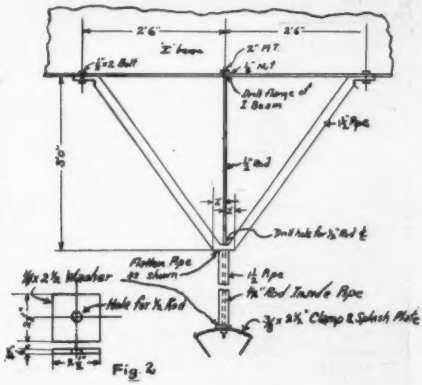


Fig. 2

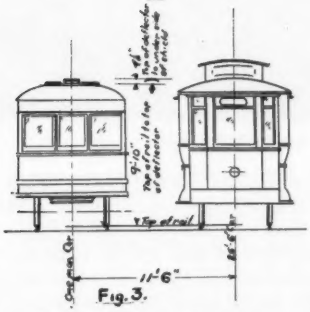


Fig. 3.

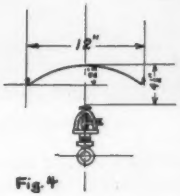


Fig. 4

Details of the special aisle sprinkler system. Fig. 1 shows the deflecting shield and support. Fig. 2 shows type of hanger used in aisle where building columns do not exist. Fig. 3 shows position of sprinkler and deflecting shield in relation to two common types of cars. The position of sprinklers on aisle lines is shown. Fig. 4 shows the relative position of sprinkler and deflecting shield.

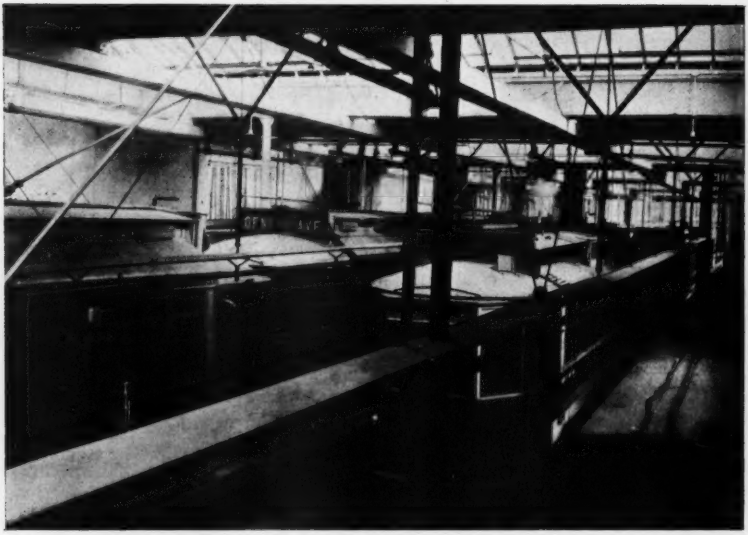
2. The ever present danger of personal injury from electric shock, resulting from contact with the piping, is a source of much concern.

3. Personal injury from striking the piping may readily occur even though not aggravated by electric shock.

4. Maintenance of the air pressure in the aisle system is troublesome and costly because the piping is so much exposed to accidental injury, and because of the liability of leaks developed by distortion.

Taking into account the above mentioned objections, and realizing that the idea of quickly extinguishing a fire inside a car must in this case be abandoned, a special system was designed, experimentally tested, and installed as shown and described below, with the thought in mind that the modified system, together with the roof system, should effectively prevent the spread of fire beyond the car of origin.

The unusual features of construction are the use of a deflecting shield over the sprinklers and the installation of only one line of sprink-



View of the first special system installed.

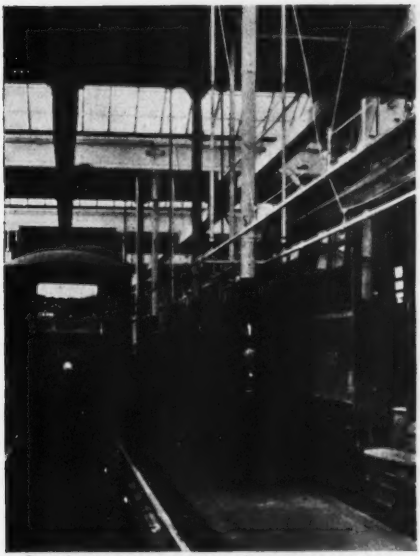
lers between cars. Pipe sizes and spacing of sprinklers are in accordance with standard rules. Before the definite arrangement was decided upon, experiments were made with the various types of cars to determine, by actual discharge through the sprinklers, (1) the proper height of sprinklers to give the most effective average protection; (2) the most favorable relative position of sprinkler and deflecting shield; (3) the proper width and curvature of deflecting shields; and (4) the effect of varying rates of discharge from sprinklers.

The arrangement shown is the result of conclusions drawn from these experiments and is believed to be satisfactory for the conditions likely to be encountered in the carhouses of the Boston Elevated Railway Company, but it is not to be assumed that identical arrangement will under all conditions give the best result. Experimental determination of the effect of various water pressures will probably show that the distance from sprinkler deflector to shield should be greater for high water pressure in order that the water may not be broken up into too fine a spray. Also the width and curvature of the shield must be varied, as the distance from sprinkler is changed, in order that too great a part of the water may not be discharged on or over the roofs of the cars.

Systematic investigation of all the combinations has not been possible, but would be of advantage and might well be made to indicate the arrangement which would give good protection under various conditions of car heights and spacing and water pressure.

As shown in Figure 1 the support for the deflecting shield is made of one piece of iron ¼″ by 1½″, formed as shown, and arranged to clamp on and serve as a part of the hanger for the aisle sprinkler piping. On the upper surface of the support is bolted the shield made of No. 24 gage

Sprinkler on special system in operation.



Standard system previously installed in car-house shown in preceding picture.

steel, thoroughly painted before installing. The shield is continuous over the whole length of sprinkler piping. To provide additional stiffness the edge of the sheet metal is turned up and lapped.

Figure 2 shows the type of hanger used in aisles where building columns do not exist. While not strictly an adjustable hanger, necessary adjustments can be readily made by changing the length of 1½" pipe and adjusting the nut on the ½" rod. This method of support does not give perfectly rigid installation, but this feature is of less importance than in the standard aisle system because the piping is high enough to be fairly well out of the way.

Support for lines in aisles where building columns were available was obtained by use of a simple clamp attached directly to the column.

One sprinkler in operation between two cars is shown in the illustration on page 351, the static pressure at the sprinkler being approximately 60 pounds. The actual density of the spray from the sprinkler is much greater than is indicated by the picture, it having been found very difficult to obtain satisfactory photographs of the discharge under the peculiar light conditions existing.

The windows of cars on both tracks are very thoroughly wet and in the case of low cars a considerable amount of water is directed upon the roof.

The system has not yet been subjected to test under actual fire conditions.

It is felt that the use of the system above described will make possible the provision of aisle sprinkler protection in places where the standard system would be omitted because of the objection to it, and it appears that the net efficiency of the special system compares favorably with the standard system as it has the particular advantages of protection from water from above and increased sensitiveness.

Life of Buried Steel Fuel Oil Tanks.

An investigation recently carried out by The Factory Mutual Laboratories regarding the life of buried fuel oil tanks indicates that underground storage, decidedly advantageous from a fire prevention standpoint, need not seriously impair the condition of steel tanks.

The investigation covered the study of tanks which had been in service from 18 months to 26 years and were buried from 10 inches to 9 feet below ground level. The soils were of sand, gravel, loam, clay or cinders or mixtures of these. In some cases ground water was present and in a few cases salt tidewater. The tanks varied in capacity from 1,100 to 22,000 gallons. In a few instances the tanks were entirely uncovered in making the investigation, while in other cases a section only was exposed. This section included one side to the center line and one end to same point. The character of corrosion, condition and thickness of shell were noted, and in a few cases the scale was examined for analysis. The results of the investigation are given in the table on the opposite page.

The electrolytic theory of corrosion is the most acceptable one. This assumes that before iron can oxidize it must pass into solution, liberating hydrogen. Corrosion is therefore stimulated by moisture, weak acids, and oxygen. Consequently steel tanks should be buried so as to eliminate these conditions as far as possible.

The conclusions from this investigation may be briefly summarized as follows:

Fill. Cinders stimulate corrosion probably because of the electrolytic action between the steel and the carbon in the cinders. Loam is a better

Age in years	Depth of top below ground	Protection and condition	Character of soil surrounding tank	Location of tank
1½	2 ft.	Red lead & asphalt Excellent	Salt marsh lower half, fill above	Everett, Mass.
7	2 ft.	Red lead	Clay, sand, trace of	So. Boston, Mass.
10	2 ft.	Excellent	cinders	
7	5 ft.	Probably asphalt Fair	Clay, sand and cinders. Salt tidewater	New Bedford, Mass.
7	7 ft.	Red lead & asphalt Excellent	Sand and gravel, ground water	Waterbury, Conn.
8	3 ft.	Asphalt—Good	Sand, loam and gravel	Lowell, Mass.
9	2 ft.	Probably asphalt Good	Sand, gravel and cinders	Worcester, Mass.
9	3 ft.	Asphalt—Fair	Sand, gravel, loam, cinders	Waltham, Mass.
10	4 ft.	Probably asphalt Good	Sand, loam, trace of cinders	Waterville, Conn.
11	7 ft.	Thick coat asphalt Excellent	Sand, gravel, few cinders	Waterbury, Conn.
11	4 ft.	Asphalt—Good	Clay and sand	So. Auburn, R. I.
12	5 ft.	Asphalt—Excellent	Oil-saturated sand. Salt tide water	New Bedford, Mass.
12	8 ft.	Concrete—Good	Encased in concrete except at manhole, ground water	Taunton, Mass.
13	2 ft.	Red lead asphalt Excellent	Sand and loam	Waterbury, Conn.
13	2 ft.	Red lead	Oily saturated sand and	Lowell, Mass.
13	2 ft.	Good	clay, ground water	
14	6 ft.	Probably asphalt Poor	Sand, gravel, cinders, trace of oil, ground water and acid.	Waterbury, Conn.
15	2 ft.	Red lead Excellent	Black mud, formerly salt marsh. Ground water	Lynn, Mass.
15	9 ft.	Red lead & asphalt Excellent	Oily sand, brackish ground water	Taunton, Mass.
15	2 ft.	Asphalt—Excellent	Clay, sand, trace of cinders	So. Boston, Mass.
16	3 ft.	Probably asphalt Good	Sand, cinders	Fitchburg, Mass.
17	5 ft.	None—Fair	Sand, gravel, cinders	Pawtucket, R. I.
18	9 ft.	Red lead and tar Poor inside	Salt water, some cinders	Brooklyn, N. Y.
20	1 ft.	Red lead Excellent	Sand and gravel	Providence, R. I.
20	2 ft.	Asphalt Excellent	Loam, clay and cinders	Cambridge, Mass.
20	2 ft.	Probably none Good	Clay and sand, ground water	Whitins, Mass.
26	2 ft.	Red lead—Good	Sand and gravel	Whitins, Mass.

type of fill than cinders although it may stimulate corrosion because its absorptive power furnishes the essentials of corrosion: oxygen and moisture. Clay is better than loam for filling. It is generally damp and delays corrosion because it holds the water in a stagnant condition Sand is the best filler and acting as a filter prevents many surface impurities from reaching the tank. Oily sand gives the best protection. Gravel is not quite as good as sand.

Protective Coating. Red lead when used alone sometimes allows contact between metal and corroding medium as film may be easily punctured. Asphalt when used alone may also permit contact. Red lead followed by asphalt gives good results. All tanks reported in excellent condition were protected by red lead, asphalt or both. No tanks examined were entirely encased in concrete. It is reasonable to suppose that concrete would offer a good protection.

Tidewater and Ground Water. Tidewater and ground water do not stimulate corrosion to any great extent. Salt water usually forms a hard encrustation. Ground water acts similarly but may stimulate corrosion when the oxygen content is great.

Depth of Bury. If a tank is buried below the zone of active oxygen it is usually below the zone of corrosion. As the depth of bury increases the tendency to corrode decreases.

Stray Electrical Currents. Stray electrical currents stimulate corrosion but these are not frequent.

General. Steel tanks buried under favorable conditions should last more than 30 years. In damp ground they will last from 15 to 20 years. To best resist corrosion steel tanks should be coated with red lead and asphalt buried in clean sand three feet deep or more below surface, avoiding ground water and tidewater if possible.

The Portable Motion Picture Booth.

Does It Afford Protection?

Underwriters Laboratories (Member N. F. P. A.) has placed in our hands a report of a carefully conducted test by its division engineer, Rufus K. Porter, upon a well-constructed portable motion picture booth, submitted by a client especially interested in promoting, if found satisfactory, the use of devices of this character.

Many states and municipalities have passed laws requiring the use of portable booths for motion picture exhibitions conducted in assembly rooms not equipped with standard fixed booths. The natural inference to be drawn from this legislation is that a good portable booth is regarded in many localities as adequately safeguarding the use of nitro-cellulose film. Portable motion picture booths are frequently used in places where the discharge of either flame or smoke in the room would have a tendency to produce a panic, while the flame might ignite combustible material in the vicinity, and the smoke carries with it the additional danger of suffocation.

The Laboratories' report describes an investigation of a portable booth designed to minimize the above mentioned hazards and intended mainly for use by non-professional operators in schools, churches, lodge halls and places of assembly where fixed booths have not been installed.

Description of Booth.

GENERAL CHARACTER:

The booth forming the subject of this report is a sheet metal box 79 inches high, 34 inches wide and 46 inches deep, outside dimensions. It is mounted on four casters 4 inches high, and a 9½-inch collar is fastened to the top, forming a vent chamber, this collar increasing the height to 92½ inches. One of the narrow ends is provided with a door 27 inches wide and 70 inches high. The other end is blank. One of the long sides, or the back of the booth, is provided with two rectangular openings 10¾ inches long and 7⅝ inches wide, and the other side, or front, is provided with two rectangular openings, the machine opening 11⅜ inches long and 6 inches wide, and the observation opening 10½ inches long and 7½ inches wide. The back is provided with fittings for the introduction of electrical wiring. The top of the booth is provided with a rectangular opening 30 inches long and 15 inches wide. All openings, with the exception of the machine opening, are covered with No. 16 mesh screening. The opening in the top of the booth is provided with a baffle plate resting on Z-shaped steel straps, holding it 5¼ inches above the netting. The collar, which is 9½ inches high, 44 inches long and 30 inches wide, surrounds this baffle plate and forms a baffle wall. The bottom is screwed to a transit board base supported by a 1½ by 1½ by ⅛ inch angle frame.

DESCRIPTION OF PARTS:

Side Walls—Each of the sides of the booth, except that providing a frame for the door, is made of a single sheet of No. 20 U. S. gauge steel. The long side forming the front of the booth is provided with two openings, a machine opening 11⅜ inches long and 6 inches wide, and an observation opening 19½ inches long and 7½ inches wide, both being provided with shutters. The long side forming the back is provided with two rectangular openings 10¾ inches long and 7⅝ inches

wide, with a 1½-inch space between them and a baffle plate placed on the interior of the booth in front of the openings. The fittings for the introduction of electrical wiring are also placed in the back of the booth. One of the short sides is blank and the other forms a frame for the door opening. The long sides are each reinforced with a horizontal steel angle 1 by 1 by ⅛ inch on the inside, and diagonal steel straps 1 by ⅛ inch on the outside. The angles and straps are fastened to the sheet steel by means of rivets, spaced at approximately 9-inch intervals. The sides are flanged at all edges and provided with holes for 1¼-inch screws securing the members together. The door side is made of No. 20 U. S. gauge sheet steel folded over and flanged out around the edges of the door opening, providing stops for the door. This side is made in four parts, two jambs, a head and a sill, the different members being fastened together at each corner by four rivets and by No. 20 gauge gusset plates, each being secured by four rivets. The door opening is 69 inches high and 24 inches wide. The blank end is a sheet of No. 20 U. S. gauge steel flanged on all sides and provided with holes for ¼-inch screws, securing it to all adjacent members.

Top—The top of the booth consists of a single sheet of steel provided with flanges at all edges and a rectangular vent hole in the center. The flanges are pierced with holes for ¼-inch screws used to fasten the top to the walls.

Floor—The bottom of the booth is made of a single sheet of No. 18 U. S. gauge steel attached to a sheet of asbestos board ½ inch thick, fitting into a frame made of 1½ by 1½ by ⅛-inch angle and supported on the corners by four swivel casters. The angle frame is provided with holes for ¼-inch screws, used in fastening the bottom to the sides.

Door—The door is made of a single sheet of No. 20 U. S. gauge steel, folded over at the edges and engaging sheet steel angles, which provide reinforcement and register against the stops of the frame when the door is closed. The door is reinforced with diagonal reinforcing angles extending from the corners of the rectangle formed by the stops. The reinforcing angles are 1 by 1 by 3/32-inch and are riveted to the door plate at intervals not exceeding 9 inches. A 12 by 6-inch rectangular opening is provided 7¾ inches from the top of the door, outside dimensions of door being 71½ inches high and 27 inches wide.

Openings—The machine opening is 6 by 11⅜ inches and provided with a gravity shutter constructed of No. 16 gauge sheet steel, sliding in sheet metal grooves and lapping the sides of the opening. The observation opening is 19½ by 7½ inches, lapped on all edges and covered with No. 16 mesh screening. The back is provided with two rectangular openings, each being 10¾ by 7⅝ inches with a 1½-inch space between. The openings are lapped on all edges and covered with No. 16 mesh screening. The door is provided with a 12 by 6-inch opening, lapped on all edges and covered with No. 16 mesh screening. The top is provided with a rectangular opening 30 by 15 inches, with the edges flanged upward 1¼ inch, and a No. 16 mesh screen covers the opening and laps the flange of the sheet metal. A baffle plate supported on its corners is placed 4 inches above the screen.

Fastenings.—One flange of the angle iron frame forming the floor of the booth is turned up and the flanges at the edges of the sheet forming the top of the booth are turned down. These flanges overlap the tops and bottoms of the sheets forming the walls. The overlapping flanges are in all cases provided with a line of holes for ¼-inch machine screws, by which the parts are fastened together; these screws passing through the holes in the flanges and the holes in the sheets and threading into nuts on the inside of the booth. The screws are placed at intervals not exceeding 6 inches.

Shelf for Machine—A horizontal shelf is placed adjacent to the blank end and is hinged to the front of the booth under the machine opening. This shelf has the sides flanged down over the edge of a ¼-inch asbestos board, to which it is secured by machine screws with nuts on the underside. The opposite end of the booth is provided with a hasp, the slot of which engages a steel pin in the back wall of the booth and is secured by a large hand nut, permitting adjustment of the shelf. The shelf is 14 inches wide and extends from side to side of the booth.

Hardware—The door is provided with three strap hinges and with two helical steel springs securing it to the frame. A handle is provided to facilitate the opening of the door.

At the diagonal corners are installed two door holders designed to rest on the floor when the booth is in position, holding it steady. These holders are commer-

Second Series, Test No. 2. 30 seconds after start of test.

cial devices consisting of a bolt with a rubber tip and spring mechanism designed to be worked by pressure of the foot; pressure on a projection of the upper end of the bolt making the rubber tip engage the floor, while it is released by pressure on small projection above the bolt.

Tests were made on two samples, hereafter designated as Samples 1 and 2. Sample No. 1 differed from the construction described in the

descriptive section of this report in that it was smaller, being only 3 feet 10 inches long, 2 feet 4 inches wide and 6 feet high over all. The sides were made with several sheets of steel instead of a single sheet, and the only openings, exclusive of the door openings, were a vent opening in the top provided with a stack, a machine opening 6 inches high and 4 inches wide, and an observation opening of the same dimensions. None of these openings were covered with screening and no baffle plates were provided. The machine opening and observation opening are protected by sliding shutters designed to close when film in the booth should become ignited. In addition it differed from the booth described in the descriptive section of this report in regard to reinforcements, method of holding the shelf in place and in being provided with a latching mechanism for the door.

Sample No. 2 was similar to the construction described in the descriptive section of this report, except that it was provided with a circular opening at the top, to which was attached a short hooded vent pipe and was not furnished with ventilation openings or baffle plates and the openings were not screened.

Fire Tests.

Five series of tests were made. The first series were made with the sample booth designated as Sample No. 1. The second and third series were made with a booth designated as Sample No. 2, the sample in the third series differing from that used in the second only in that various sized stacks were fitted to the vent opening at the top. The booth used in the fourth series of tests was substantially the same as used in the second and third series, except for the openings. One of the long sides of the booth was provided with two rectangular openings 10 inches long and 5 inches wide and the other was divided with a machine opening 11⅜ inches long and 6 inches wide, and an observation opening 6 inches long and 4 inches wide. The top of the booth was provided with a hole 8½ inches in diameter, fitted with a flange for the vent stack.

The sample used in the fifth series of tests was that described in the descriptive section of this report.

Three tests were made in the first series, one with the door latched and two with the door shut but the latches disengaged. In the first two tests the slides were open, closing automatically when the fire burned the string with which the slides were held up. In the third test the slides were left closed. In each test two pieces of film approximately 6 pounds were used, part of one reel being unrolled and the free end projecting through the door opening and lighted from outside the booth.

In the second series four tests were made. In each of the first three tests two rolls of film were used and in the fourth test three rolls. In each of the tests the rolls were placed on the shelf and about 50 feet of film was loosened from one roll and allowed to accumulate in a pile on the floor. These tests were made in the roof testing room at the Laboratories, at the top of a brick stack 60 feet high and a floor area of approximately 166 square feet. The top of the stack is normally closed by two shutters. During the tests one of these shutters was open, providing an opening of approximately 24 square feet. In each of these tests the film was ignited by tossing a lighted match into the loose film on the floor and immediately closing the door.

The third series of tests was primarily made to aid the manufacturers in their development work, the size of the vent opening being changed after each test by the introduction of a reduction stack. In the third test a rectangular opening was cut in the bottom of the booth to determine its effect upon the fire.

In the first test three rolls of film were used and two rolls in the second and third tests. In all cases the film was placed on the shelf and about 50 feet loosened and allowed to accumulate on the floor. This loose film was ignited by tossing a lighted match into it and shutting the door.

In the fourth series five tests were made. In Test No. 1 of this series two rolls of film weighing 8 lb. 2 oz. were placed on the shelf and 50 feet of film loosened and allowed to accumulate on the floor. The machine and observation shutters were held open with wrapping cord. The temperature of the film was taken by means of thermo-couples placed within reach of the flame.

In the second test of this series one roll of film weighing 3 lb. 15 oz. was placed on the shelf and 50 feet loosened and allowed to accumulate on the floor. The machine and observation shutters were held open with wire. The temperature measurements were taken as in the preceding test.

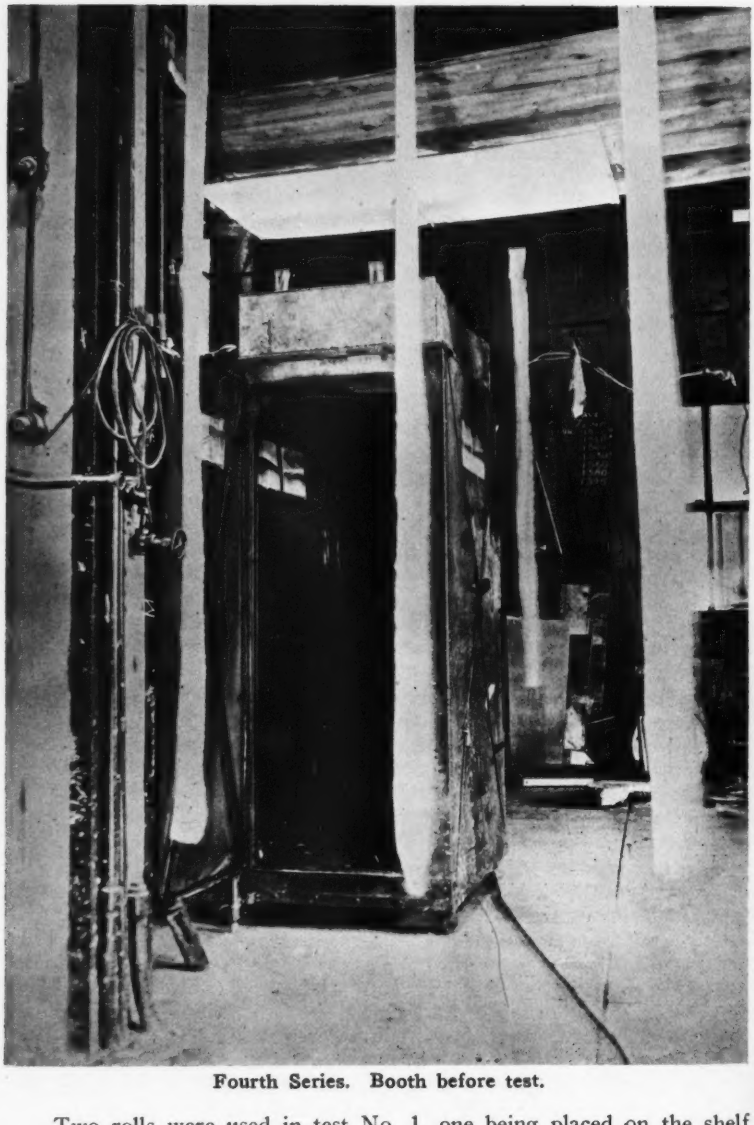
In the third test two rolls of film weighing 3 lb. 15 oz. each were placed in the booth, one on the floor and the other on the shelf. The roll on the shelf was placed nearest to the front of the booth, with 50 feet of film loosened and allowed to accumulate on the floor directly beneath the roll, and the roll on the floor was placed leaning against the back of the booth. The shutters were held open with wire and the temperature noted.

In the fourth test of this series two rolls of film weighing 3 lb. 15 oz. each were placed in the booth, one on the floor and the other on the shelf. The roll on the shelf was placed nearest to the front of the booth, with 50 feet of film loosened and allowed to accumulate on the roll of film on the floor, which was placed beneath the one on the shelf. The shutter was held open with wire and all openings were covered with a No. 14 mesh copper screen.

In the fifth test of this series one roll of film weighing 4 lb. 7 oz. was placed on the shelf and 50 feet of film was loosened and allowed to accumulate on the floor. The shutters were held open with wire and all openings were covered with No. 14 mesh wire netting.

In all of these tests an attempt was made to measure the projection of flames through the opening by means of balls of cotton suspended on wires at different distances. In each test the film was ignited by tossing a lighted match into loose film on the floor and immediately closing the door.

In the fifth series of tests the sample was placed beneath the roof 10 feet above the floor, which was constructed half of wood and half of plaster board and divided at the center of the booth. Strips of cotton were placed approximately 50 inches from all sides of the booth and attached to the framework holding the roof. Five tests were made in this series.



Fourth Series. Booth before test.

Two rolls were used in test No. 1, one being placed on the shelf and the other on the floor. Fifty feet of film was loosened from the reel on the shelf and allowed to accumulate near the reel on the floor. The machine opening was closed and a No. 14 mesh screen placed over

the top of the wall enclosing the baffle plate, making a double screened opening with a baffle plate between. The temperature of the flame was noted by a thermo-couple placed above the film and strips of film and paper were held in contact with the sides of the booth to indicate the intensity of the heat radiated.

In Test No. 2 two rolls of film weighing 4 lb. 8 oz. each were placed as in Test No. 1. The No. 14 mesh screening was replaced by a sheet metal plate provided with a hole in the middle 8 inches in diameter. Temperature and radiation were noted as before.

In Test No. 3 two rolls of film were placed in the booth as in Test No. 1. The baffle plate between the two screens was removed. All other conditions being the same as in Test No. 1 of this series.

Test No. 4 of this series was introduced for the purpose of comparison. A flammable platform approximately 40 inches high was constructed and two rolls of film weighing 4 lb. 5 oz. each were used, one placed on the platform and the other on the floor. No walls or shields were provided for the flame.

In Test No. 5 the opening in the top of the booth was reduced one-half and a baffle plate and screen were used as in Test No. 1. Two rolls of film were used, placed as in the previous test.

In each test the films were ignited by tossing a lighted match in the loose film on the floor immediately below the door.

Results.

First Series.

Test No. 1—The slides for closing the operation and observation openings were closed and the door was latched. Under these circumstances the only flame extending out of the booth was that coming out of the ventilator at the top and a solid cylinder of flame spouted from this opening, impinging on the hood and extending upward at least 6 feet. There was considerable smoke in addition to the fire, probably enough to fill a small-sized hall or lecture room.

Test No. 2—In the second test the slide failed to close and jets of flame approximately 2 feet in length shot out of these openings. The pressure inside caused the door to open slightly from time to time, a sheet of flame approximately the height of the door and about 2 feet in length coming out at each period. There was considerable smoke, the amount being about the same as in the first test.

Test No. 3—In the third test the slides were left down and the results were much the same as in the second test, except that slightly more flame issued from the crack in the door the time that it was first opened.

Summary—There was no breaking of the fastenings or tearing of the metal and the booth was not distorted at the completion of the test, indicating that the booth as made was strong enough to withstand the stresses occasioned by the burning of film. The amount of flame issuing from the ventilator stack appeared to be about the same in all tests and the fierceness of the fire varied with the amount of loose film unrolled from the reels. In all cases the flame duration outside the booth did not exceed 2 minutes. The amount of smoke was practically the same in all tests and is considered to have been sufficient in quantity to seriously endanger an audience. In most cases the passage of flame would be sufficient to ignite the building or building contents if of a flammable nature.

The heat caused by the fires inside the booth was not sufficient to cause paper in contact with the outer walls to burst into flame, although there was some charring of the edges, indicating that ignition of the building or building contents would not result from heat radiated by the booth.

It was evident that the travel of fire was not particularly fast until loose film was ignited, but this ignition of loose film was instantly followed by a burst of flame that entirely filled the booth. While the burst of flame was not quite so extensive when the fire reached a tightly rolled film, even in this case the flame

filled the booth and the ignition was so sudden that an operator would have little or no chance to fumble for a latch.

In general the tests indicated that any film fire in a booth would be attended with considerable risk to the audience. Flame and smoke would issue from the booth and very likely cause a panic.

SECOND SERIES.

Test No. 1—Four seconds after the door was closed a burst of flame forced the door partly open, the flame extending approximately 1 foot from the opening. The door closed immediately and was again forced ajar by the flames and then closed and remained closed throughout the test. No flame came from the stack until 14 seconds after the fire was lighted, at which time the fire had evidently ignited film in the roll, as the compartment became filled with flame which extended out of the stack and was deflected down by the cap. This flame lasted from 2 to 3 seconds, after which no flame was visible on the outside of the booth. The flame extending out of the stack was not sufficient in quantity to ignite cotton strips hanging within 2 feet of the top of the booth.

The smoke that was issuing from the stacks and from the vent hole for the first 14 seconds was light gray in color and not of great density. At 17 seconds the flame from the top vent had ceased, but dense masses of smoke came from the vent and from all the cracks in the cabinet, this smoke rapidly darkening in color, becoming reddish-brown and completely filling the brick stack to the testing room. It will be noted that this stack is 60 feet high and 166 square feet in floor area. The smoke had the appearance of nitrogen peroxide fumes (NO_2) and was extremely irritating to the throat.

Test No. 2—In the second test of this series, 4 seconds after the door was closed, a burst of flame forced it open about 1 inch, the flame extending about 6 inches between the opening. The door closed immediately and remained closed throughout the test. At 20 seconds flame from the vent was 6 inches in length, rapidly increasing to 4 feet and at 30 seconds impinging against boards placed 4 feet above the top booth. At 35 seconds the cloth strips ignited and the boards ignited about 4 seconds later. All flame had ceased issuing from the vent at 2 minutes and 25 seconds and at no time was there a great amount of smoke issuing from the booth.

Test No. 3—In the third test of this series no flame issued from the door at any time. Flame came out of the vent in 14 seconds, setting fire to the cloth strips in 25 seconds and to the boards in 1 minute and 15 seconds. All flame had ceased at 2 minutes and 20 seconds. Very little smoke issued from the booth at any time.

Test No. 4—In the fourth test of this series the flame from the initial ignition of the film burst the door slightly open and the flame extended 2 or 3 inches out of the crack so formed. In about 14 seconds there was some flame out of the top of the vent, but much less in volume than in the two preceding tests. After the test had been running for about 3 minutes and 15 seconds there was a muffled explosion inside the booth, accompanied by a burst of flame which forced the door open, the flame extending out of the booth for a distance estimated at 3 feet.

During this test masses of smoke began issuing from the booth in approximately 20 seconds, the amount being estimated as sufficient to fill an ordinary classroom or small hall in less than 2½ minutes. This smoke is believed to have been sufficient in quantity to cause suffocation.

Summary—These tests indicate that a film fire inside of the booth tested causes flame which would extend outside of the booth, the duration, extent and location of flame depending on the amount of film burning, the tightness with which it was rolled and the ventilation in the booth. In many cases the passage of flame would be sufficient to ignite flammable material placed close enough to the booth to be damaged by the flame. It is not probable that flame extending from the ventilator stack would ignite an ordinary lath or plastered ceiling; it would ignite flammable decorations such as flags or woodwork 4 feet above the top of the booth.

These tests indicated that booths of the construction tested are liable to so smother the fire, that instead of burning freely it will smolder, causing an immense amount of smoke. This smoke would issue from the booth and rapidly fill the chamber in which the booth was located. The fumes are considered to be somewhat poisonous and are believed to have been sufficient in quantity to cause

suffocation. Although no tests were made at this time to determine whether these fumes were flammable, it would seem very probable that they were. This is of importance when it is considered that in the last test of this series an explosion inside of the booth, accompanied by a burst of flame, forced the door open. It would seem probable that if this burst of flame occurred when the booth was surrounded by dense fumes in a hall these fumes might have been ignited.

In none of the tests was the heat caused by the fires inside the booth sufficient to ignite paper in contact with the outer walls. Small pieces of this film placed in contact with the outer walls puckered but did not burn. The highest temperature noted on the side of the booth was approximately 250° F., indicating that ignition of the building or building contents, if it occurred at all, would result from direct contact with the flame rather than from radiated heat.

It was evident in this series of tests that the ignition of loose film is generally accompanied by a burst of flame, but after a lighted match had been tossed in the loose film the engineer in charge had sufficient time to assure himself that the film was ignited and to close the door, taking several steps away from the booth before this burst of flame occurred. It seems, therefore, that under ordinary conditions an operator would have plenty of time to leave the booth, although if there was a great quantity of film on the floor and the operator did not notice it when it first became ignited, he would have small opportunity of escaping.

Third Series.

Test No. 1—In the first test of this series two rolls of film were used and the film ignited in the usual manner. Flame issued from the vent hole at the top at about 14 seconds and puffs of flame burst the door open slightly in about 17 seconds. Dense masses of smoke came through the vent hole and the flame seen outside the booth was smothered in approximately 25 seconds. The smoke filled the brick stack to the testing chamber in about 2 minutes.

Test No. 2—The results of this test were practically a duplicate of the preceding test. While some flame did show at the vents or cracks, dense masses of smoke issued from all apertures.

Test No. 3—Before making this test an opening at approximately 12 inches long and 8 inches wide was cut in one of the side walls of the booth. Three reels of film were used in the test, 50 feet of one reel being unrolled and allowed to accumulate on the floor. The film burned freely in this test, flame extending out of the stack approximately 4 feet and out of the vent hole at the bottom approximately the same distance. Practically no smoke issued from the booth at any time.

Summary—These tests indicated that the only method of securing combustion of the film without the attendant smoke hazard was to create a draft by providing openings by which air could enter the booth. It was evident that a structure which had a tendency to smother the ignition would greatly endanger an audience from smoke and one that would permit free burning of film would possibly cause a panic from flame extending out of the booth and plainly visible.

Fourth Series.

Test No. 1—Flame extended about 5 feet from the rear ventilating openings, 6 feet above the top of the booth and 6 feet from each of the machine and observation openings. The fire was completely out at 2 minutes and 45 seconds, reaching the maximum temperature of 1210° F. No flame issued from the booth at any time.

Test No. 2—In the second test of this series the flame came out through all openings but did not extend so far as in the previous test. The fire was out in 1 minute, reaching the maximum temperature of 1030° F. No smoke issued from the booth at any time.

Test No. 3—In the third test of this series the results were similar to those of Test No. 2, the maximum temperature being 1010° F. and the flame extending approximately 3½ feet from all openings. The reel of film on the floor was intact after the test.

Test No. 4—In this test, flame projected from the top of the booth 3 feet and extended from the openings on the side about 1 foot. The fire died down in 1 minute and 30 seconds. The gas appeared to ignite after passing through the wire screening, which apparently retarded the flame from spreading as in Tests 1, 2 and 3.

Fourth Series, Test No. 1. 25 seconds after ignition of film.

Test No. 5—In this test the fire was entirely inside the booth for the first 20 seconds, flames coming through the openings at 25 seconds. The entire test lasted 1 minute and 35 seconds, and the maximum temperature inside of the booth was 790° F. Smoke and gas filled the booth after the flames were out.

Summary—The heat caused by the fires inside the booth was not sufficient to cause paper in contact with the outer walls to burst into flame or to char perceptibly. Small pieces of film placed in contact with the outer walls puckered but did not ignite. The temperature on the outside was not sufficient to ignite parts of the

building or building contents. There was sufficient flame to ignite flammable material with which it came in contact, but it should be noted that the duration of this impingement of flame would be for a short period only. This series of tests indicated that a film fire in a booth of the construction tested would be attended with a considerable risk to the audience and that this danger would be more the danger of a panic caused by the sight of a large volume of flame than from actual fire. Most of the fire in the first three tests came from the vents at the top and sides. The top vent was well above the heads of an audience, but the side flames would spread out directly in their faces.

Fifth Series.

Test No. 1—In the first test of this series there was no smoke, but flame impinged against the ceiling 20 seconds after the film was ignited. This impingement lasted 30 seconds and the fire was apparently out at 60 seconds. The flame, upon striking the ceiling, spread out and burned four strips of cotton approximately 50 inches beyond the edge of the booth. The boards of the ceiling were ignited in the joints, but went out after the flames died down, except for glowing embers in the cracks. The plaster board was intact after this test except for a slight discoloration. The maximum temperature of the flame was 1140° F.

Test No. 2—In this test the flame impinged against the ceiling 30 seconds after the film was ignited, this impingement lasting 40 seconds and the fire was apparently out at 85 seconds. The lateral spread of flame was approximately 5 feet on all sides and the maximum temperature was 800° F. The result of the flame hitting the ceiling was practically the same as in Test No. 1.

Test No. 3—The flames in this test were of practically the same volume as in the first tests, reaching their maximum in 15 to 62 seconds after the film was ignited and were all out at 75 seconds. The maximum temperature was 1090° F. The burning of the ceiling and cotton strips showed the same results as in the first tests.

Test No. 4—It will be noted that in this test the film was burned without a surrounding booth. The flames reached their maximum height in 20 seconds and were all out at 65 seconds. The flames impinged against the ceiling, but the fire did not appear to be as fierce as when in the booth.

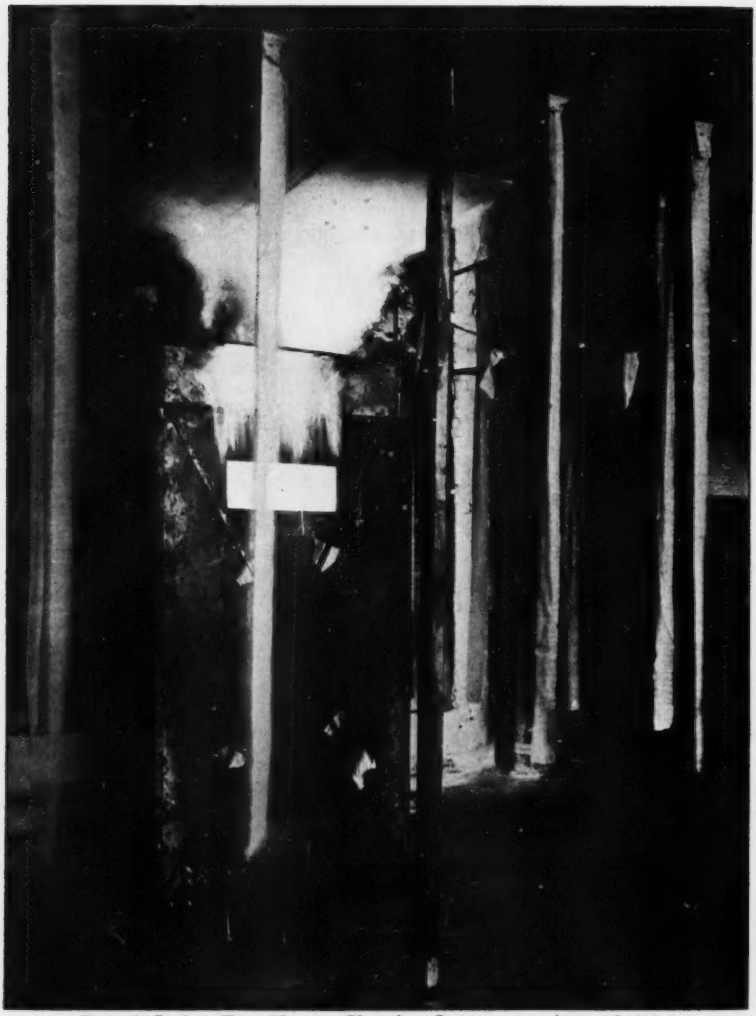
Test No. 5—In the fifth test of this series the same results developed as in the previous test. The maximum height was reached 30 seconds after ignition of the film and lasted 25 seconds. The entire flame was out at 70 seconds.

Summary—This series of tests indicated that a film fire in a booth would be attended with considerable risk to the audience and that this danger would be due more to panic resulting from the sight of a large volume of flame issuing from the top of the booth than from actual danger from the fire. Very little fire came out of the vent openings in the sides, thereby eliminating the danger of direct contact of flame with the audience. The flame impinging against the ceiling spread laterally hugging the ceiling and if no decorations and curtains were near by the fire would not spread so as to become dangerous to the audience.

Conclusions.

The booth in its perfected form can easily be taken apart and crated for shipment in a manner making the possibility of damage negligible. The assembly of the booth is not difficult and does not require skilled mechanics or special tools. It can be easily moved about on its casters and the springs holding the door in the closed position are sufficiently strong for the purpose intended. It is large enough to permit easy movement of the operator and at the same time is sufficiently small to permit its passage through an ordinary sized door opening. Damage to most of the parts could be repaired by ordinary workmen. Damage to the metal panels would require the attention of a mechanic accustomed to working on sheet metal. It is subject to some vibration and an operator would probably make considerable noise. These defects could be remedied.

While the booth can easily be taken apart and crated, it is possible



Fourth Series, Test No. 1. Showing flame at maximum height.

that it would be damaged if shipped without crating. The rules and requirements of various states covering the construction of moving picture booths specify a larger booth than that forming the subject of this report. Judging from the standpoint of practicability it is not felt that a larger booth would be better. The operator has sufficient room for operating the machine without bringing his body in contact with the sides of the booth and no booth is large enough to permit the operator remaining in it after a fire is once started in the film.

The door holders at the corners of the final sample, made the booth somewhat stiffer than the one originally submitted, but still some vibration is possible.

It would be impossible to prevent the operator from making considerable noise if the floor sheet was not flat against the asbestos backing. This last is simply a question of workmanship.

DURABILITY:

The booth as constructed would probably withstand for long periods the effect of wear and tear and such rough usage as it might reasonably be expected to receive. If properly painted it would probably be unaffected by corrosion.

In spite of the fact that most of the detailed structural requirements in force specify a more rigid framework for the sides of the booth, none of the tests demonstrated any weakness. No evidence of corrosion was noted on any of the samples and it does not seem probable that a device of this character would be subjected to atmospheric conditions likely to cause corrosion. Nevertheless painting would be advisable.

STRENGTH:

The device is sufficiently rigid for the purposes intended and the parts are sufficiently strong to withstand such stresses as they are likely to be subjected to.

In the final sample described in the descriptive section of this report the sides were constructed of a single piece, and while these sides bent during handling there was no pronounced tendency to buckle and none of the parts were at all injured in assembling or disassembling the booth. The assembled booth was rigid, could be moved about without distortion and did not break, tear or materially distort under fire, indicating that it is strong enough for the purpose for which it was designed.

FIRE HAZARD:

The booth does not radiate sufficient heat to set fire to surrounding flammable material, or under ordinary conditions to parts of the building structure. The burning of the film in the booth would cause the flames to extend up a sufficient distance to strike any but a very high ceiling, and after impinging on the ceiling would extend sideways. The duration of these flames is not sufficient to ignite any but the most flammable material.

During the tests in which the greatest spread of flame was noted the maximum time of burning was approximately 85 seconds and in none of the tests did the flame extend out of the booth for a greater length of time than 47 seconds. An ordinary plastered wall would not ignite if subjected to a flame for so short a length of time. Trimmings or curtains of a flammable nature would ignite if in contact with this flame.

The results of the burning of the film in the open and in the booth showed very little difference except that the entire fire was visible in one case and not in the other. The time of the burning varied about 15 seconds, the film burning in the open taking the least time. The space occupied by the open fire was practically the same as when the booth was used and the open fire did not appear more dangerous than the fire in the booth.

LIFE HAZARD:

The booth as designed does not furnish the protection to life necessary in a device of this kind.

In each of the Fire Tests either the quantity of smoke or flame was sufficient to induce panic.

SUMMARY:

The investigation indicates that the feasibility of constructing a practical portable booth which can be depended upon to reduce both the fire and life hazard is problematic and emphasizes the desirability of confining the use of nitro-cellulose film to buildings provided with fixed booths vented to outside air and to professional operators.

It is essential that a booth which materially reduces the hazard to life and property should be so constructed as to permit the burning of film without smoke and at the same time so muffle the flames that they cannot be seen in great volume or set fire to combustible material near the booth.

With a view of meeting these essential requirements the manufacturers of the booth forming the subject of this report have insured perfect combustion by providing openings for the admission of air and have unsuccessfully attempted to confine the flame to the booth by wire screening and baffle plates. In general, the results of the test were not such as to encourage the submittors in attempting to control the flame in this manner; and the protection to life and property provided by the final construction is considered as being little if any greater than were the films burned in the open room.

The results of the entire investigation emphasized the necessity of using slow burning film rather than attempting to safeguard the use of nitro-cellulose film under the conditions given.

Fire.

With torn and living tongues the flames leap.
Hungrily
They catch and lift, to beat their sudden wings
Toward freedom and the sky.
The hot wood sings
And crackles in a pungent ecstasy
That seems half pain of death, and half a vast
Triumphant exultation of release
That its slow life-time of lethargic peace
Should come to this wild rapture at the last.

—Eunice Tietjens.

Gas Masks for Fire Fighting.*

The U. S. Bureau of Mines has tested and used many types of self-contained oxygen breathing apparatus in fighting mine fires and in rescuing miners trapped in poisonous gases resulting from fires or from explosions in mines. Similar devices have been used by city fire fighters but have never been considered entirely satisfactory owing, largely, to their weight, to the time necessary for adjusting them to wearers, and the constant care required to maintain the apparatus in good working condition. Hence there has long been need for a light, easily adjusted, and dependable breathing apparatus for protecting fire fighters from irritating and poisonous gases and smokes.

As a result of the war the gas mask, which uses a chemical filter for removing poisonous gases and fumes from air, has been developed to a high state of perfection. The mask used by the United States Army is capable of giving complete protection against all the deadly gases that have been met on the battlefield, but it does not protect against all the gases or atmospheres encountered in mines and in the industries and in fire fighting.

The dangers from gases that city firemen face and the need of standardized methods of protection against them have been pointed out by Chief John Kenlon, of the fire department of New York City, who also mentioned the knowledge firemen should have of gases. The need of such knowledge has been especially emphasized by over-confidence in the capacity of the Army type of gas mask to protect the wearer against industrial gases, an assurance that has probably arisen because soldiers were taught that the Army gas mask would protect them against all the gases they might encounter. This statement, true for the battlefield but not true for all industrial gases, including products of combustion, has been brought back by soldiers and spread generally among workers. Furthermore, city firemen and mine operators have been circularized with letters and advertisements of Army gas masks offered for sale by certain persons who made unreserved statements, probably through ignorance, that the masks would protect wearers in mines and burning buildings. The falsity of these statements was evident to the Bureau of Mines, which took steps immediately to notify the public that Army gas masks had serious limitations, especially when used in fire fighting or in any place where unusually heavy amounts of poisonous gas are present. This warning has been verified by the actual experiences of some city firemen who have tried Army masks. On the other hand, the excellent qualities of the masks have also been demonstrated at fires.

The work described in the paper, prepared by engineers of the U. S. Bureau of Mines, was undertaken to obtain information regarding the

*Extracts from Technical Paper 248 of the U. S. Bureau of Mines. This paper, bearing the title "Gas Masks for Gases Met in Fighting Fires," was prepared by Messrs. Fieldner, Katz, and Kinney of the Bureau.

use of the Army type of mask for fighting fires and for doing rescue work in mines and the mineral industries.

It includes also descriptions of breathing apparatus other than gas masks, descriptions of most of the gases met in the industries, of their physiological effects when inhaled and of methods of treating persons who have been gassed.

Experiences of Fire Fighters Where Masks Were Inadequate.

New York City, pier fire.—Two men wearing Army masks were overcome while putting out a fire on a pier where sulphur was burning.

Chicago, rag-shop fire.—One fireman while wearing an Army gas mask was overcome by products of combustion at a fire in a rag shop. He had been in the shop about 30 minutes and his condition was such that he was sent to the hospital.

Detroit, celluloid fire.—Gas masks were found to give inadequate protection to firemen in a fire in a varnish factory in Detroit, Mich. Celluloid in the burning building gave off carbon monoxide and oxides of nitrogen.

Experiments by the Bureau of Mines have shown that when celluloid burns in insufficient oxygen the gaseous products contain rather high percentages of carbon monoxide and oxides of nitrogen. If the supply of air is cut off entirely, the combustion may be continued by means of the combined oxygen contained in the celluloid itself. Chemical fire extinguishers are of slight value in fighting celluloid fires; water serves as well as anything. The Army gas mask will absorb the oxides of nitrogen, but not the carbon monoxide in the gases produced.

Rochester, N. Y., basement fire.—The Rochester Democrat and Chronicle of June 19, 1919, described a fire at which firemen wearing Army masks were overcome. Firemen who entered the basement found that the dense smoke was mixed with ammonia from the refrigerating plant and with illuminating gas from a broken pipe leading to a gas meter. Illuminating gas contains considerable proportions of carbon monoxide. Several men were overcome and one was so badly affected that he was taken to the fire house in an ambulance. About 20 men suffered from the effects of the gas in the basement, but most of them recovered shortly after they came out into the air. No one seems to have been seriously affected.

Experiences Where Masks Were Useful.

Pittsburgh, Pa., fire in waste-paper plant.—In contrast to the foregoing citations, masks of the Army type have proved useful at some fires, as was witnessed by one of the authors at a fire in the warehouse of the Pennsylvania Paper Stock Co., in Pittsburgh, Pa., July 1, 1919. The building had four stories, was of fire-resistive brick construction, and contained large quantities of baled scrap paper and rags. Twenty-one firemen were injured, most of whom were overcome by smoke and required hospital treatment. The building was ventilated by breaking nearly all the windows. Under these conditions firemen wearing commercially produced gas masks of the Army type, equipped with filters in the canisters for removing smoke, were able to work in the worst part of the building, in shifts of 25 to 30 minutes each, for a period of five or six hours. Under the same conditions men without masks would work for five minutes, come to fresh air to rest and recuperate, and return to the work in the building for another five minutes, when they would come out with eyes swollen nearly shut by the smoke and so weakened that hospital treatment was necessary.

Spring Lake, N. J., garage fire.—Four firemen wearing gas masks were able to work in a garage filled with smoke.

New Brunswick, N. J., cellar fire.—At a very smoky cellar fire firemen wearing Army gas masks entered, ventilated the building, and located and extinguished the fire.

Camden, N. J., fire in wall-paper factory.—At a fire in the Hitchner wall paper plant, February 18, 1919, gas masks were used to get at the fire, and resulted in a saving of thousands of dollars.

Moline, Ill., fires in storerooms.—Two fires occurred in storerooms which filled with heavy thick smoke. Firemen wearing gas masks were able to enter the building and work with a line of hose.

Duluth, Minn., fire in wooden dwelling.—The fire started in the basement of a wooden dwelling and had spread into the walls on the second story when the fire department arrived. An unprotected man was unable to enter the second story because of the smoke. The assistant chief, wearing an Army gas mask, entered the second floor, ventilated the place, and thus enabled the other men to work there.

Discussion of the Experiences.

At the pier fire where sulphur was burning the firemen may have encountered sulphur dioxide gas in concentrations greater than the canisters could absorb completely. Besides this instance of the failure of an Army gas mask to protect its wearer against a high concentration of a gas that is readily absorbed in lower concentrations, the Army masks are shown to give no protection against carbon monoxide and ammonia.

Altogether, the examples show the wide variety of situations in which the gas masks have been used. An early discussion of the use of gas masks for fire fighting stated that firemen are entering smoke-filled areas every day without the use of appliances, and, therefore, the gas masks offer protection of some value, as they are adapted for use in the great majority of fires. The instances cited previously where the gas mask has proved useful are few, but are varied enough to show the many different situations where gas masks are proving valuable aids many fire departments of the country, so undoubtedly their usefulness has greatly increased. On the whole, the incidents show the usefulness of the gas mask to fire fighters, but demonstrate also that undue risks should not be taken with them.

Experiments Conducted.

The properties and effect on man of various products of combustion were examined in the experiments conducted by the Bureau of Mines. The ordinary poisonous and asphyxiating gases encountered by firemen are carbon monoxide, soot, tar, and smoke vapors, oxides of nitrogen, sulphur dioxide, ammonia, chlorine, illuminating gas, gasoline vapor, and gases from carbon tetrachloride extinguishers. The various types of breathing apparatus and gas masks were subjected to test with these gases, particular attention being paid to the army gas mask. The conclusions with regard to it are stated by the authors in the following paragraphs:

Utility of Army Gas Masks in Fighting Fires.

Whether or not firemen should adopt the Army gas mask for general use has been much discussed. Theoretically it would seem that the half-hour oxygen-breathing apparatus, which keeps out all gases and supplies oxygen, would be much safer than the gas mask for fire fighting. But practical experience shows that firemen, as a rule, do not favor oxygen-breathing apparatus. To them it seems cumbersome and uncertain in action. The combination of oxygen cylinder, breathing bag, regenerator canister, valve and pressure gage appears too complicated for the rough and ready work of fire fighting. Although such apparatus has been on the market for a number of years, it is seldom put into practical use, even when on hand, at fires. Firemen prefer to take their chances unencumbered, or at most simply to tie a wet handkerchief or towel over the nose and mouth to keep out some of the smoke.

Therefore the utility of the gas mask must be considered from the practical point of view rather than the theoretical. A review of the many reports of tests in experimental fires by city fire departments shows: (1) That firemen are favorably impressed with the simplicity of the gas mask and will wear it; (2) that in the great majority of these tests it protected the eyes and throat from irritating smoke and was a great improvement on sponge respirators and wet cloths; (3) that the mask did not encumber the wearer or retard his effectiveness in fire fighting; (4) that no special training was required in learning how to use the mask; (5) that in comparison with the oxygen-breathing apparatus very little attention is required to keep the gas masks in good condition.

These experiments by fire departments corroborate the experiments of the Chemical Warfare Service and of the Bureau of Mines in proving conclusively that the Army gas mask, when fitted with a canister containing cotton filter pads, activated charcoal, and soda lime, effectively filters out irritating smoke particles, and, in addition, protects against most chemical fumes in the concentrations likely to be met in fires.

However, in using the Army mask the following serious limitations must be kept in mind: (1) It furnishes no oxygen; hence it should not be worn in a place where a safety lamp or a fireman's oil-burning lantern will not burn; (2) it should not be used where there is reason to suspect carbon monoxide, as in smoldering fires in basements and other confined, unventilated spaces, and especially in confined places where broken illuminating gas pipes add carbon monoxide to the air; (3) it offers very poor protection against ammonia; (4) finally, the Army mask may break down in unusually high concentrations of poisonous gases. It was originally designed for outdoor use, where the poisonous gases are considerably diluted with air. Caution must be used, therefore, in going into rooms where the concentration of the accumulated gas may be great enough to pass through the mask.

Recommended Gas Mask for Fire Fighters.

Perhaps the most serious limitation of the Army mask for fire fighting is its inability to protect against ammonia and carbon monoxide. Because of the deadly concentration of the latter gas in mine fires, the Army mask should never be used in burning mines. Although special ammonia canisters are now available commercially, and carbon monoxide canisters soon will be available, the fire fighter does not know in advance what gas or combination of gases he may find. Many buildings contain ammonia refrigerating plants, and all cities outside the natural gas belt are piped for artificial gas containing carbon monoxide. The fireman, therefore, must have, in a single mask, protection against all these gases, either by attaching several canisters to the same face piece or by increasing the size of the fireman's canister to about three times the volume of the present Army canister. This larger canister should contain special absorbents for ammonia and carbon monoxide, when the latter is developed, in addition to the present filling of charcoal, soda, lime, and filter pads. It is hoped that this type of mask will be made available in the near future. With such a canister, a fireman could safely enter any atmosphere in which a safety lamp would burn.

Water Japan.

A process where water is substituted for flammable solvents such as naptha now used in japanning has been developed by the General Electric Company. This process was developed for the primary purpose of eliminating the fire risk of japanning, one of the most serious of hazards in many industries. Water Japan has recently been approved by Underwriters' Laboratories, as follows:

"No. 821 Water Japan." Consists essentially of an emulsion of an asphaltic japan base in water. To be used by the manufacturer in japanning processes, enameling ovens, etc.

The hazardous properties of the product are judged to be relatively small, the rate of hazard being between 0 and 10 as determined by Underwriters' Laboratories' Schedule for classification, in which Ether rates 100, Gasolene rates 90-100, Turpentine rates 40-50, Kerosene rates 30-40, Paraffin oil rates 10-20.

The process is already in use in several plants of the General Electric Company, and is described in the *General Electric Review* from which the following extracts give the fundamental features involved:

Baking japan, as it is ordinarily used in industry, consists of a "base" and a "solvent." The base contains one or more of the various asphalts, together with one or more siccative oils such as linseed oil or china-wood oil. The finished base is a tough rubbery mass which looks much like tar. It is the office of the solvent to dilute this base to a liquid, so that the metal may be easily coated with the desired amount of japan base. The solvents in common use are naphtha, kerosene, and similar products. The use of such solvents entails a considerable fire risk, especially in the oven in which the japanned metal is baked. It was to eliminate this fire risk that "water japan" was developed.

Water japan consists of an emulsion of japan base in water. By this is meant that an enormous number of tiny ultra-microscopic globules of japan base float around in the water japan in much the same way that globules of butter fat swim around in ordinary sweet cream. The diameter of the globules is about 0.00001 inch. The emulsion is permanent, showing no tendency to settle out even after several months. It may be strained in the same manner as ordinary japan and, if desired, may be cleaned in a commercial clarifier of proper design. Since water is the "solvent," the losses due to evaporation are negligible, especially if the japan is kept cool. Scum will not form on the surface if the temperature of the liquid is kept below 100 deg. F. (38 deg. C.). After the water japan is baked, it is quite insoluble in water. The range of concentration which may be successfully used is very great, so that little supervision is required.

The viscosity of water japan is much less than that of the same base dissolved in kerosene or similar solvents. There is a possibility that, in the future, methods may be worked out by which the viscosity of water japan will be so adjusted that metal may be coated with water japan by dipping in the same way as with ordinary japan. However, the advantages of employing certain entirely different methods of applying the japan base to metal before baking seemed great enough to justify their development. They all have this feature in common—the japan base is deposited on the metal in a solvent-free condition. In this way, the behavior of the japan in the baking oven depends entirely on the characteristics of the japan base employed so that "secondary drip" is rendered negligible. These methods of applying water japan are given in detail below.

The Electric-dip.

The electric-dip method is adapted to small odd jobs of japanning rather than to quantity production. The water japan is put in an iron tank which is connected to the negative terminal of a direct-current circuit. The metal to be coated is connected to the positive terminal of the circuit. Since the globules of base in the water japan carry negative charges the base will be attracted to the positively charged metal. The water is left behind, so that the metal is covered with a thin film of japan base, free from solvent. This film possesses some insulating properties even before baking, so that, as soon as the most exposed portions of the metal are coated, deposition starts in whatever holes and recesses may still be bare. The thickness of the deposit of base depends upon the product of the current-density and the time. Using a 125-volt circuit, the time required for a satisfactory coat is about 2½ seconds. In using the electric-dip method no special voltage is necessary. The work is connected directly across a direct-current line of high current carrying capacity without series resistance, so that the current flowing will be proportional to the area to be covered. The current on 125 volts will average about 0.8 ampere per square inch of surface to be covered. Due to the polarization effect, the current is higher at the instant the circuit is closed than at the moment of breaking. Time is most conveniently measured by means of a time switch connected to a relay. Accidental short circuits are prevented by a wooden grating on the sides and bottom of the tank. It is absolutely necessary that the surfaces of the metal to be coated be free from grease or other insulating material. During the time the japan base is being deposited, the metal should be submerged at least two inches below the surface of the water japan so as to allow it to be in approximately uniform electric field. Only one coat can be given by the electric-dip process as baked water japan acts as an insulator.

The Hot-dip.

The hot-dip method is adapted to work with large quantities of small castings, punchings, etc., where it is essential that the labor cost be kept at a minimum. The metal to be japanned is placed in wire baskets and heated in an oven to a temperature of about 500 deg. F. (260 deg. C.). It is then cooled to about 400 deg. F. (200 deg. C.) and quickly plunged into the cold water japan. The japan base leaves the water and collects in a film on the surface of the metal. After the basket has remained in the water japan about ten seconds it is removed, drained for about 30 seconds, and placed in the baking oven, where it is baked in the usual manner. After baking, the basket is emptied into storage boxes. The baskets may be handled entirely by chain-falls or an air-hoist, so that upwards of 100 lb. of metal can be handled at once. Except when the pieces of metal to be coated are very small, reinforced baskets of ½-inch mesh wire screen are suitable. The metal is often shoveled directly into these baskets, especially if it is in the form of small irregular castings or punchings. In some cases, however, it is advantageous to pack the contents of the baskets systematically, either for the sake of getting in a greater number of large pieces or of determining where the points of contact from piece to piece shall be. There is no handling of the individual pieces from the time the basket is filled until it is finally emptied into the storage box. Pre-heating was originally developed as a cheap method of cleaning grease and oil from metal before japanning. It is especially useful on steel punchings, and on brass, copper and aluminum. Most grease of this sort is thoroughly cleaned off if the metal is heated to a temperature of 500 deg. F. (260 deg. C.) and kept there for a half hour. It was soon found that if this preheated metal was quickly plunged into water japan while still hot (250 to 400 deg. F.) that the heat in the metal had the same effect as the electricity in the electric-dip process in causing the japan base to adhere to the metal leaving the water behind. There was this additional advantage, that the surface of japan base immediately in contact with the metal started to bake from the residual heat of the metal, thus tending to insure good adhesion.

In case the metal to be coated has flat faces, there is a chance that two flat faces may lie together so that neither of them would get a satisfactory coat. This may easily be obviated by dumping the hot contents of the basket into the water japan, catching the metal in another basket below.

Due to the fact that there is practically no "secondary drip" with water japan the scars due to the contact of one piece with the edge of another in the basket are negligible. After baking, the baskets are usually emptied by turning them upside down. In case it is desired to give more than one coat of japan, the basket is taken out hot from the baking oven and at once dipped. It is then put back to be rebaked.

Montreal City Hall Fire.

By D. C. Winsor,
Canadian Fire Underwriters' Association.
(Member N. F. P. A.)

The Montreal City Hall has been added to the long list of large public buildings which have been destroyed by fire. Early in the morning of March 4, 1922, a fire of unknown origin completely gutted the large structure. The loss to the building alone was over $500,000. This loss is a direct tax on the people of the city as no insurance was carried, with the exception of a municipal fund which had been set aside during the past few years to cover such a contingency. The amount available from this source is, however, small in comparison with the actual loss.

Construction.

The city hall was erected in 1878 and may be considered typical of the old style of public building. It was a 3½-story and basement structure with four corner towers and one central tower at north side and one at south over the main entrance. The building was one large area, approximately 25,000 square feet. The general construction was brick with stone facing, wooden beams, and joists with unprotected cast-iron columns, hollow wooden lath and plaster finish throughout, with a large mansard roof, large open light wells, open elevators and stairs through all floors.

It was occupied throughout with the usual civic offices with little protection for storage of records, although a recently constructed fire-resistive vault under ground outside of the building proved its value by saving a large portion of the more valuable records and plans. Up to a few years ago the city fire alarm telegraph headquarters was located in the top of the 5½-story tower, but fortunately had been relocated in another section of the city.

Inside Protection.

Local fire protection consisted of standpipes and hose with chemical extinguishers on all floors. A city fire alarm box was on the main floor

The Montreal City Hall was destroyed by fire on March 4, 1922. This is a typical illustration of the results of fire in large wooden joisted buildings with unprotected vertical openings.

with auxiliary boxes throughout. Night watchman service with records was maintained, while the janitor slept on the premises.

Story of the Fire.

The fire was discovered by the watchman and an alarm was received from box at fire alarm headquarters at 11:44 P. M. This alarm was followed by a second at 11:51 P. M., a third at 12:02 A. M. and a fourth at 1:08 A. M. The first company to arrive, a motor hose wagon with only two blocks to travel, attacked the fire in the basement where it had apparently originated amongst a large number of bales of waste paper about midway of the building on the north side. The battalion chief, responding from the same station, found fire in the first floor and realizing the danger, sounded second and subsequent alarms. The fire was fought from the inside for a time but after the blaze had a firm hold on the roof, streams were worked from the outside, there being ample room on all sides of the burning building. A total of twenty-nine hose companies, twenty-four ladder companies, thirteen steam fire engines, four motor pumpers, six salvage wagons, one water tower, two siamese wagons besides usual fuel wagons, etc., were in attendance. Forty streams using 26,000 feet of hose from hydrants and engines were used, besides the water tower; 3069 feet of ladders were raised and 250 salvage covers spread. A large number of covers and abandoned hose lines were lost when roof and floors collapsed.

The fire spread through the roof and to each of the towers, all being destroyed, the last tower to go being the southwest, where the fire was stopped before it burned down through the floors. With the collapse of various towers and roof, floors were carried through to the basement and

practically only the walls of building and towers remained. The floors of the tower that was saved were afterwards carried down, by the collapse of a large chimney a few days after the fire, during a strong wind.

Apparently the fire had gained considerable headway before its discovery and had a good hold in basement and walls by the time the fire department arrived. Once into the mansard roof the chances of stopping it were slight and little could be done to prevent the destruction of the building.

There was no loss of life, but Capt. Riley of the Fire Department lost an eye from injury by hot particles of falling glass, received in the early stages of the fire, and four other firemen were slightly injured by broken glass.

There is no new lesson from this fire, it merely serves as another illustration of the folly of this type of construction, especially for large public buildings.

Fire Record—Chemical Plants.

It is not surprising that a classification of chemical plant fires indicates that about 71 per cent of the total known causes of fire are due to hazards incident to the industry. It is difficult to devise an adequate classification of these special hazard fires because in many instances the rapidity of spread of the fire has prevented ascertainment of the exact cause. Accordingly many of these fires have necessarily been attributed to the rather indefinite items of "Ignition of Chemical," "Ignition of Inflammable Vapor," etc. In so far as possible the exact cause or the process responsible has been given. While some of these fires are perhaps unpreventable it seems probable that the majority of them were due to carelessness. The common hazard fires are fairly generally distributed, heating being the main cause. Many of these fires could probably be indirectly traced to the inflammable nature of the materials stored and in process.

The sprinkler record is very satisfactory considering the large number of severe fires in this class. Only five and a half per cent of sprinkler fires were failures. A comparison of wet and dry systems indicates that the systems were about equally efficient. The average number of sprinkler heads opening is 23, an unusually high figure. This is another indication of the severity of fires in this occupancy.

Slightly more fires occurred in the day time than at night. In chemical plants the hazard would naturally be greater during operation of the plant.

About forty per cent of the fires involved losses of over one thousand dollars. It is worthy of mention that eighty per cent of the fires causing loss of over one thousand dollars were in unsprinklered properties. Fifty-seven per cent were due to hazards incident to the industry.

Chemical Plants — Fire Record.

Total Number of Fires Reported 473.

CLASSIFICATION OF CAUSES.

Common Causes.

	No. of Fires	Per Cent of Common Causes	Per Cent of Known Causes
Heating	22	19.4	5.6
Matches—Smoking	16	14.2	4.1
Power	14	12.4	3.6
Lighting	13	11.5	3.3
Spontaneous Ignition	12	10.6	3.1
Sparks from Locomotive	8	7.1	2.0
Exposure	7	6.2	1.8
Defective Electric Wiring	6	5.3	1.5
Incendiary	5	4.4	1.3
Defective Flues	4	3.5	1.0
Lightning	3	2.7	.8
Misc. Common Causes	3	2.7	.8
Total	113	100	

Special Hazard Causes.

	No. of Fires	Per Cent of Special Causes	Per Cent of Known Causes
Ignition of chemical	38	13.6	9.8
Explosion of chemical	33	11.9	8.4
Overflow or boiling over of chemical	31	11.2	7.9
Spontaneous ignition of chemical	30	10.8	7.7
Foreign substance in grinding mill	24	8.6	6.1
Ignition of inflammable vapor	20	7.2	5.1
Drying room	16	5.8	4.1
Explosion of apparatus	16	5.8	4.1
Overheating of kettle or oven	14	5.0	3.6
Sparks ignite chemical	13	4.7	3.3
Spilling of acid or ether	8	2.9	2.0
Ignition of oil	7	2.5	1.8
Ignition of gas	5	1.8	1.3
Ventilating fan	4	1.4	1.0
Miscellaneous special hazard causes	19	6.8	4.9
Total	278	100.0	100

		Per Cent of Total
Common Causes	113	24.0
Special Hazard Causes	278	58.8
Total Known Causes	391	82.8
Unknown Causes	82	17.2
Total	473	100.0

ANALYSIS OF LOSS.

	Loss Less $1000	Per Cent	Loss More $1000	Per Cent	No Data	Per Cent	Total	Per Cent
Common Causes	72	31.0	35	18.0	6	13.3	113	23.6
Special Hazard Causes	138	59.3	111	57.0	29	64.5	278	58.7
Unknown Causes	23	9.7	49	25.0	10	22.2	82	17.7
Total Cause	233	100	195	100	45	100	473	100
Sprinklered Fires	127	54.5	38	19.5	3	6.5	168	35.6
Unsprinklered Fires	106	45.5	157	80.5	42	93.5	305	64.4
Total Fires	233	100	195	100	45	100	473	100

Sprinkler Fire Record.*

	No. of Fires	Per Cent
Extinguished Fire	78	61.4
Held Fire in Check	42	33.1
Unsatisfactory	7	5.5
	127	100.0

*There were 41 fires in which no sprinklers opened

COMPARISON OF WET AND DRY SYSTEMS.

	Ext. Fire	Held in Check	Unsatisfactory	Total
Wet System	48	23	6	77
Dry System	30	19	1	50
Total	78	42	7	127

NUMBER OF SPRINKLERS OPENED. (AVERAGE 23.)

No. of Sprinklers Operating	No. of Fires	Per Cent
1	34	26.8
2	14	11.0
3	8	6.3
4	7	5.5
5	7	5.5
6-9 inclusive	15	11.8
10-25 inclusive	20	15.7
26-50 inclusive	10	7.9
51-100 inclusive	4	3.2
101-200 inclusive	5	3.9
Over 200	3	2.4
Total	127	100.0

Miscellaneous Statistics.

DAY OR NIGHT FIRES. (Day Fires 6 A. M. to 6 P. M.)

	No. of Fires	Per Cent
Day	262	55.3
Night	196	41.5
No Data	15	3.2
Total	473	100

HOW DISCOVERED

	No. of Fires	Per Cent
Employee	315	66.7
Watchman	57	12.1
Outsider	36	7.6
Sprinkler Alarm	15	3.2
Watchman & Sprinkler Alarm	14	3.0
Thermostat	2	.3
Sprinkler Alarm & Supervisory	2	.3
No Data	32	6.8
Total	473	100

Some Typical Fires in Chemical Plants.

Ignition of Alcohol Vapor.

H-10645. At the time of the fire an iron still, 200 gallons capacity, was being used to recover alcohol by distillation. A gas light was located at the still for reading a thermometer. It is believed that the distilling process became deranged in some way, permitting the escape of a large quantity of hot alcohol which became ignited from the open gas flames in the room. Exactly what happened is not known as the chemist, who was the only person in the room, was killed by the ensuing explosion. The fire and explosion severely damaged the building. Another man was killed by a falling beam. The fire was extinguished with considerable difficulty owing to the large quantity of alcohol involved.

Explosion of Apparatus.

H-10778. The plant was engaged in making phosphoric acid in an electric furnace. At the time of the explosion the furnace was in full operation, containing a charge of phosphate rock, coke, and sand, and was heated to a temperature of approximately 1,700° C. One of the nozzle plugs that permits molten slag to discharge from furnace to cooling pit blew out, and immediately the molten contents discharged into the cooling pit. Some water was in the pit and the rapid generation of steam caused by the molten slag falling in the water caused an explosion that scattered slag at high velocity throughout the building. A fire was caused by some of the slag being forced against 2,300 volt, 3-phase wires and exposed single pole knife switches in a nearby transformer room. A short circuit

immediately occurred, which heated the wires to incandescence and ignited the wood work of roof and walls. The fire was extinguished by employees, much of the equipment being damaged by water.

Overflow of Chemical.

H-11604. In this plant nitric acid was manufactured by heating sodium nitrate, in stills, with sulphuric acid. The sodium nitrate was usually brought to the stills in a conveyor but this had broken down and it was necessary to take the nitre in bags and empty it into the stills by hand. The bags were then thrown to one side and afterward removed. It so happened on the morning of the fire that a small number of these bags had been thrown to one side, a short distance in front of the furnaces. One of the men was drawing the hot liquid (acid sulphate of soda) from a small opening near the bottom of one of the stills when in some unknown manner it overflowed, coming in contact with the pile of bags. These instantly blazed up, making a hot fire and igniting the board wall of the building. The building and contents were practically destroyed.

H-12845. The contents of caustic fusion tanks, used in preparing synthetic phenol, was being drawn off by means of open metal troughs to acidification tanks nearby. Apparently a little splashed over sides of trough and on account of its high temperature (500° F.) it ignited fuel oil which had dripped on the floor from the fuel oil burners that heat the tanks. This blazed up and set fire to the light wood platforms around the tanks. The bases of these platforms were oil soaked and burned rapidly. The fire spread and destroyed the building which was of light frame construction.

Ignition of Chemical.

H-13162. This fire was the direct result of carelessness of an employee. The plant was manufacturing chlor-benzol. The workman started to fill the benzol storage tank from a tank car. It is said he was under orders to leave the car west of the extreme end of the potash building and connect up pipe to it from tank. Instead of doing this, he moved the car up to a point nearly opposite the chlor-benzol plant and directly opposite the potash furnaces, which were in operation only fifteen feet away. In some way the benzol became ignited. The outlet of the tank car consisted of an inside valve, protected by metal plate. It is considered probable that this valve was open, and when the coverplate was taken off to attach the pipe line, the benzol leaked out, falling into the coal pit, and almost instantly reaching the potash furnaces and being ignited. The workman was seriously burned and was rescued with great difficulty. The chlor-benzol plant was practically destroyed. The interior of the potash building was not damaged, although two of the brick panel walls were so badly spalled that they had to be rebuilt.

Sparks Ignite Chemical.

H-14092. Fire occurred in a picric acid plant in the acid-washing building. Picric acid is washed with water and the water is then extracted by centrifugals. These are driven at high speed by belts and it is believed that when one was stopped, the friction of the belt caused a spark which ignited the acid. Three workmen at hand ran instead of attempting to

extinguish the incipient fire. As a consequence the fire spread rapidly and five buildings were badly damaged.

Explosion of Chemical.

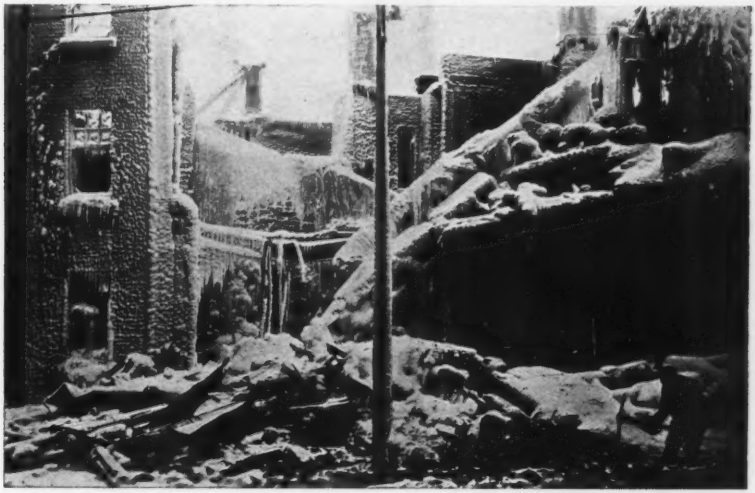
H-16709. The plant where this explosion occurred manufactures dye intermediates and reduces the nitro derivatives to obtain toluodines. The process consists of nitrating toluol and then running the resulting mono-nitro-toluol by gravity in enclosed iron pipes to another building where it is reduced and distilled, the distillation being done in a vacuum still heated by an open flame kerosene oil burner. The needle valve in the gauge on the still stuck and the foreman opened the gauge in an attempt to release the needle valve without shutting off the fire. Usually when the gauge is open none of the contents of the still escapes on account of it being under vacuum. Presumably there was a leakage and some of the contents of the still escaped, getting on the clothes of the foreman. The fumes, coming in contact with the open flame, set him afire. He then ran from the building calling for help and leaving the gauge open. More of the liquid escaped, filling the building with an explosive mixture of fumes and an explosion occurred which threw down the upper walls of the building, a fire-resistive structure.

Foreign Substance in Grinding Mill.

S-22830. Fire occurred in the grinding room of a plant manufacturing coal tar dyestuffs. The grinders consisted of a number of circular discs revolving at high speed. The material to be ground is thrown against a wide steel ring inside of which the discs revolve. The ground color is discharged from the mill with considerable velocity into horizontal steel-cased mixers. A vent to relieve air pressure is provided in the form of a cloth balloon with a return pipe to the grinder. An iron bolt accidentally got into the grinder and when a spark was struck, fire instantly flashed through to the mixer and out again to the balloon where a mild explosion took place. The flame flashed through the room and to the floor above. Sprinklers did good work in extinguishing the fire although several barrels of color burned for some time. The loss was small considering the severity of fire.

Smoking.

S-27768. Fire occurred in a section of the plant used for making saccharine. In the process, toluol is brought into the room in steel drums and siphoned into small glass bottles to carry to mixing tanks. Two men were working in the room. A spark from a cigarette ignited the toluol. A flash fire followed and one man was killed and the other badly burned. The fire quickly ignited the contents of a toluol drum and the head blew out, spreading the burning fluid. All the sprinklers operated but could not extinguish the flames, water having but little effect on the burning toluol. The building was of reinforced concrete and was not badly damaged.



Montreal Apartment House Fire.*

A fire which broke out on the evening of January 22, in the Notre Dame de Grace section of Montreal, cost the lives of two firemen and destroyed a block of apartments with a loss of over $100,000.

The fire was discovered just before seven o'clock by a tenant. It was issuing from a Chinese laundry on the ground floor. An alarm brought the nearest station apparatus in a few moments and streams were promptly turned on the fire although the zero weather hampered the firemen. The tenants were warned and there appeared to be ample time to remove property if necessary. A group of firemen entered the laundry to get at the fire. An explosion followed, throwing the front of the building into the street. Two firemen were buried in the ruins. A general alarm brought most of the city apparatus but it was midnight before the fire was under control.

The cause of the fire is not known. It is thought that the explosion was caused by gasoline in the laundry or in a clothes-cleaning establishment in the basement. The two large apartment houses which were gutted comprised between them thirty-three apartments. Some twenty dwellings and business premises were also burned.

If the fire had occurred a few hours later it is highly probable that there would have been heavy loss of life amongst the tenants of the buildings. There was only one stairway four stories high at the rear, where it would have been extremely difficult to erect a ladder.

*Data and photograph by courtesy of George H. Greenfield (Member N. F. P. A.).

Lexington Hotel Fire, Richmond, Va.

By L. S. Jones.
(Member N. F. P. A.)

A fire which broke out at 4 A. M. on February 7, 1922, in the Lexington Hotel, Richmond, Virginia, cost the lives of twelve people and swept through nearly half a city block with a loss of about half a million dollars.

Construction.

The hotel, which was built over sixty years ago, was of old style brick and wooden joisted construction. It was located among other old inflammable buildings and was recognized as a serious fire hazard by the city authorities and the insurance interests. An elevator shaft of wood and metal ran up through the center of the building. There were three fire escapes on the hotel, two of which were of the stairway and balcony type. The third was simply a vertical iron ladder. There were two open stairways from the lobby floor to the second floor, and from this floor to the third and fourth floors there were three open stairways.

Cause of Fire.

At the time of the fire extensive repairing and painting was being done. The hotel was not closed, however, and guests were in their rooms as usual. The fire apparently started in a small room on the second floor near the elevator shaft. This room was used by the painters, who had left twelve suits of overalls in this room on the night of the fire. It is highly probable that the fire was due to spontaneous ignition of oily rags in the pockets of some of this clothing.

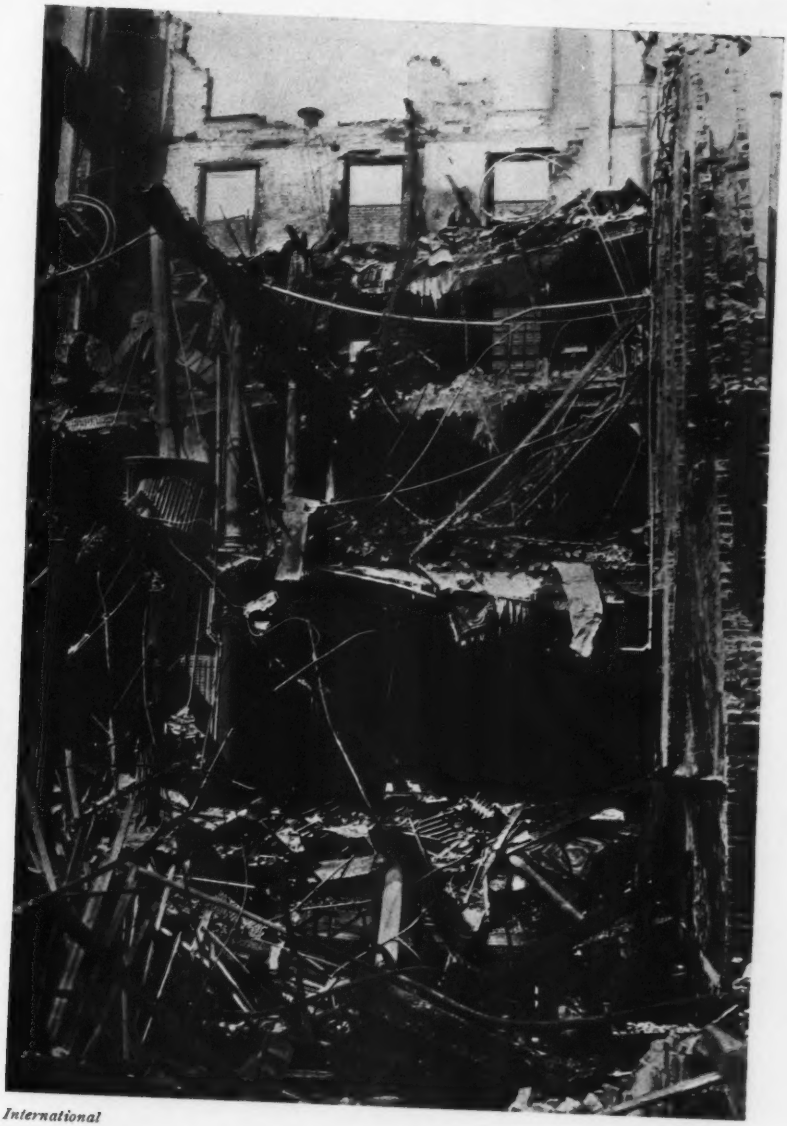
Story of the Fire.

The fire spread rapidly up the elevator shaft and was blazing through the roof at least twenty-five minutes before the alarm was received.

The night clerk on duty was old and infirm and apparently lost his wits and overlooked both the house fire alarm and the city alarm box on the corner. The first alarm was sent in from a box two blocks away by a messenger boy who saw the fire at a distance.

Two hook and ladder companies had been assigned to respond to a first alarm from the box directly in front of the building because of its well known hazard, but the box from which the alarm was sent had only one hook and ladder company assigned to it, and the route was down a steep grade not traversed on the route to the box directly in front of the hotel. The delay involved undoubtedly cost several lives.

The first alarm was received at 4:34 A. M., the second alarm at 4:38 A. M. and a general alarm at 4:55 A. M. When the first truck arrived men were already jumping out of the windows. The fire was blazing through the roof and coming out nearly every window on one side. It



International

A section of the interior of the Lexington Hotel, Richmond, Virginia, after the fire of February 7, 1922, which cost the lives of twelve people.

International

The extent of damage caused by the fire is indicated in this picture. Note the congestion of buildings and the old style of construction.

seems probable that the stairs served as flues for the smoke and heat, and were not available. All the stairs did not run from first floor to the top story but instead two stairs stopped at the second floor where the fire started and it was necessary to walk down a long corridor before reaching the stairs to the first floor.

The fire spread rapidly, badly damaging seven other buildings. It was finally controlled by the excellent work of the fire department.

Loss of Life.

Men were jumping from the windows when the firemen arrived. The first company responding to the alarm saw one injured man crawling a half block from the hotel. This engine company was only two blocks from the fire and was there in less than two minutes after the alarm was sent in. There were twelve lives lost, seven by jumping from the windows, and five by burning. Those that were burned were so badly burned that only the torsos were left, and in two cases the bodies could not be identified. Others that were burned were identified by either their teeth or some article found close to them in the ruins. All of those losing their lives were men. A number of thrilling rescues and escapes were made. A woman about seventy years old jumped from the third story of the hotel across a fifteen-foot alley to the top of a two-story building and was rescued from there without being seriously injured. Others came down water conductors. Some came down ropes the painters had on the side of the building. Some were apparently burned in their beds. Many escaped by tying sheets together and sliding down to safety. One

man was coming down on a sheet from the third floor, when another man caught it and both fell. The firemen caught them in a life net and neither one was seriously hurt. Some jumped from windows when there was a fire escape within three feet of them. The first truck to arrive saved at least thirty persons with its life net and aerial ladder.

Findings of the Grand Jury.

A special grand jury investigated this fire and, while holding that no evidence was found of criminal violation of the law, declared that there was evidence of gross carelessness, incompetence and a want of proper regard for the safety and lives of guests and employees. They pointed out that the building inspector and the fire prevention board should have had the authority to close the hotel on account of the chaotic conditions due to alterations. The grand jury recommended a new ordinance regulating hotels with full power given to the fire prevention board to enforce all regulations.

Fires in Which There Was Loss of Life.

These notes are intended to point out typical conditions under which loss of life has occurred, that they may be known and guarded against.

Defective Stove Insulation.

H-17981—Toledo, Ohio. Fire starting in the kitchen, a one-story addition of a two-story frame dwelling, cut off the only stairway of the main structure and trapped a mother and four children. The mother could have escaped from an upper window but went back after the children and was overcome by the smoke.

Inflammable Film.

H-18142—Kewanee, Ill. A moving picture operator was suffocated when he attempted to control a fire in the operating booth. Fire was caused by a short circuit or broken film and ignited some film on the floor of the booth. The owner of the theatre assisted the operator in fighting the flames and as no headway was being made went out to call the Fire Department. The operator did not leave and died of suffocation before he could be rescued.

Gasoline.

H-17957—Devil's Lake, N. D. A farm hand carried a lighted kerosene lantern into the granary and started to fill the lantern, while lighted, from a fifty-gallon tank. He was killed by the ensuing explosion. It is thought that the oil company delivered gasoline instead of kerosene as ordered.

H-31092—Brooklyn, N. Y. A watchman with a kerosene lantern passed a benzine storage room in a shoe factory. The lantern ignited fumes accumulated at the foot of a stairway, and his clothing took fire. Becoming crazed he attempted to get out a barred window although a bunch of keys were at his waist. He was burned to death before help could reach him.

Children Left Alone.

H-18146—Spartanburg, S. C. A farmer's wife left two children in a room where an open fire was burning while she went to the barn to feed some stock. The older child was playing with the fire and set fire to the bed. The dwelling was quickly burned to the ground. When the house was nearly consumed some one noticed the four-year-old boy under the house unhurt but the two-year-old baby was burned to death.

H-18019—North Beverly, Mass. A mother left three children while she went to a store to purchase provisions. It is thought that the clothing of one of the children caught fire from the kitchen stove and that the clothes of the other two caught when they tried to smother the flames. The one-story frame dwelling burned rapidly and was in ashes when firemen arrived.

Kerosene.

H-18137—Detroit. Fire in a farm house, two miles north of Detroit, caused the death of eight persons, seven of them children. The fire was caused by the farmer's wife attempting to kindle the kitchen fire with kerosene. The spread of flames was so rapid that the eight victims were burned to death in their beds.

Gas Heater.

H-18173—Los Angeles. A little girl, six years old, with two sisters and a brother, were huddled around a gas heater. Her clothing became ignited, and when the neighbors came in, her clothing was entirely burned. She died in the hospital shortly after.

Fuel Oil.

S-31651—Westbrook, Me. Three men were smothered to death and another seriously burned when a locomotive, burning oil, backfired in a roundhouse. Three of the men were riveting a tank when the engineer drove his locomotive into the roundhouse for a supply of fuel oil. The oil was supplied from a 300-gallon gravity tank with bottom elevated seven feet above the tracks. The fire box door of the locomotive was open and the fuel oil vapor ignited from this flame. The engineer managed to escape but could not turn off the flow of oil. Fumes swept into the tank and smothered two of the men. The third managed to climb out of a small opening at the tank top and got as far as the floor when he was smothered. The engineer escaped with severe burns. This fire emphasizes the hazard of the gravity tank in connection with any oil supply.

Rubbish.

H-18174—Johnstown, Pa. Fire in the basement of a building partly occupied by a newspaper publishing plant caused the death of a newsboy who was sleeping there. The management of the paper had been repeatedly notified by the fire chief that the waste paper in the basement should be baled and removed and had taken no action. There was an open coal chute from an alley at the rear. It is believed that a cigarette was carelessly thrown in here by some motorists who had stopped to repair a tire. The fire spread rapidly with large loss to the building. The remains of the newsboy were found in the basement one month after the fire and it was determined that he had been suffocated by the smoke. The newspaper company had not objected to newsboys sleeping in the basement.

Annual Summary.

Statistics of Fires in Properties Having Automatic Sprinkler Protection.

NOTE.—These tabulations are made at the close of each fiscal year, with the object of furnishing a basis upon which the virtue of the automatic sprinkler as an extinguishing agent can be estimated.

Section I is devoted to fires in which the behavior of sprinklers was, for the reasons given, unsatisfactory.

Section II is a statistical record of all reports of sprinkler fires in the files of the Association upon which the information obtained is sufficiently complete for statistical purposes.

In each table the results of the current year ending February 1, 1922, are given, and these are compared with the results of the total twenty-five year record ending at that time.

Section III includes new tables giving data on the efficiency of the primary water supply to sprinkler systems.

The total number of sprinklered fire reports received during the past year is 2256. The number of fires in which the sprinklers were not a factor* or which were discovered and extinguished before there was sufficient heat to open the sprinklers was 698. This compares with 971 for the year ending February, 1921, and 741 for the year ending April, 1920. The number of fires in which sprinklers operated is 1558 as compared with 1933 last year. The number of failures for the two years are respectively 67 and 60, making the per cent of satisfactory operation 95.9 and 96.9. This slightly more unfavorable showing for the past year is probably due to lower business morale and lax standards of housekeeping.

The sprinkler and supervisory alarm service continue to make an excellent showing.

The tables giving number of sprinklers operating have been enlarged so that a comparison of wet and dry systems can be made. These tables indicate clearly that the wet system acts more promptly than the dry system. The wet system extinguished 53.1 per cent of the fires with two heads or less operating as compared with 33.0 per cent for the dry system.

The new tables on secondary water supplies to sprinkler systems (for discussion see page 95, July, 1921, QUARTERLY) have been made a part of the annual tables and appear as Section II, Tables 10 and 11.

A new section, giving data on the efficiency of the primary water supply to sprinkler systems, has been included. In preparing these tables, reports previous to January 1, 1910, have been disregarded. It is felt that the 16,722 fires recorded since that time form a sufficient basis for satisfactory conclusions. Many of the early reports are deficient and inaccurate. New tables will hereafter be based on the data since 1910.

*By not a factor is meant fires that occur in unsprinklered portions of a building.

SECTION I.

Summary of Unsatisfactory Sprinkler Fires.

	1921-1922 No. of Fires.	1921-1922 Per Cent.	1897-1922, incl. No. of Fires.	1897-1922, incl. Per Cent.
Water shut off sprinklers	28	41.5	332	29.0
Generally defective equipment	4	6.0	239	20.8
Unsprinklered portions	3	4.5		
Defective water supply or supplies	7	10.5	106	9.3
Sprinkler system crippled due to freezing	..	..	39	3.5
Slow operation of dry system or defective valve	4	6.0	26	2.3
Slow or defective operation of high test heads	..	..	19	1.6
Faulty building construction, concealed spaces, vertical openings, etc.	5	7.5	56	4.9
Obstruction to distribution	1	1.5	63	5.5
Hazard of occupancy too severe for average sprinkler equipment	3	4.5	62	5.4
Explosion crippled sprinkler system	6	9.0	55	4.8
Exposure or conflagration	3	4.5	71	6.2
Plugged heads	1	1.5	40	3.5
Miscellaneous	2	3.0	36	3.2
Total	67		1144	

Special Classification of Fires in Which Failure Was Due to Water Being Shut Off Sprinklers.

	1921-1922. No. of Fires.	1897-1922. No. of Fires.
Water shut off for unknown reason, neglect or carelessness	14	127
Water shut off before fire was out or fire re-kindled	2	48
Water shut off due to accidents or repairs	3	57
Water shut off to prevent freezing	6	66
Water shut off, probably incendiary	..	6
Water shut off, leaky dry system	..	11
Water shut off, miscellaneous	1	12
Water shut off, defective gate valve	2	5
Total	28	332

SECTION II.

Annual Revision of Sprinkler Fire Tables.

In the following eleven tables is given a summary of fires occurring in properties equipped with automatic sprinklers. The total number of such fires reported during the past year is 2256, which includes 698 fires where no sprinklers were opened. Several reports were also received in which the data was incomplete, and these were not used in the summary. It will be noted that the total number of fires does not agree throughout all the tables. This is because some of the reports of fires prior to 1909 were not considered sufficiently complete to include in all the tables, and hence appear in some tables, but not in others.

Table No. 1.—Time of Day.

	No. of Fires. 1921-1922.	No. of Fires 1897-1922, incl.	Per Cent of No. with Data Given. 1921-1922.	Per Cent of No. with Data Given. 1897-1922, incl.
6 a. m. to 6 p. m.....	807	14049	52.5	57.0
6 p. m. to 6 a. m.....	733	10581	47.5	43.0
Total with data given.....	1540	24630		
No data.....	18	450		
Total.....	1558	25080		

Table No. 2.—How Discovered.

	No. of Fires. 1921-1922.	No. of Fires. 1897-1922, incl.	Per Cent. of No. with Data Given. 1921-1922.	Per Cent. of No. with Data Given. 1897-1922, incl.
Employee	724	14229	46.8	58.1
Watchman	242	3655	15.7	14.9
Sprinkler Alarm	339	4089	22.0	16.6
Outsider	124	1295	8.0	5.3
Thermostats	32	749	2.1	3.1
Automatic Pump	..	11	..	.05
Supervisory System	83	494	5.4	2.0
Total with data given.....	1544	24522		
No data.....	14	558		
Total.....	1558	25080		

Table No. 3.—Efficiency of Alarm Service, 1921-1922.

NOTE: This table does not include fires where alarm service does or does not operate promptly if fire is at once discovered by employees, the alarm service having no bearing on such fires one way or the other.

	Satisfactory.		Failure.		Total.
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	
Watchman alone	152	96.8	5	3.2	157
Sprinkler Alarm alone	232	98.8	3	1.2	235
Thermostats alone	2	66.7	1	33.3	3
Supervisory System alone....	2	100.0	..	..	2

Table No. 3—Efficiency of Alarm Service, 1921-1922—Continued.

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm	88	52	127	13	..	..	..	..	140
Watchman and Thermostats	..	2	..	..	2	..	..	..	2
Sprinkler Alarm and Thermostats	..	..	24	1	20	5	..	..	25
Watchman, Sprinkler Alarm and Thermostats	..	3	3	..	3	..	..	..	3
Sprinkler Alarm and Supervisory	..	..	91	..	..	..	90	1	91
Watchman and Supervisory	1	..	..	..	..	..	1	..	1
Watchman, Sprinkler Alarm and Supervisory	8	30	38	..	..	..	37	1	38
Sprinkler Alarm, Thermostats and Supervisory	..	..	7	..	6	1	7	..	7
Watchman, Sprinkler Alarm, Supervisory and Thermostats	..	1	1	..	1	..	1	..	1

Efficiency of Alarm Service, 1897-1922, Inclusive.

	Satisfactory.		Failure.		
	No. of Fires.	Per Cent.	No. of Fires.	Per Cent.	Total.
Watchman alone	2088	90.7	214	9.3	2302
Sprinkler Alarm alone.....	2448	94.8	134	5.2	2582
Thermostats alone	191	79.3	50	20.7	241
Supervisory alone	59	98.4	1	1.6	60

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman and Sprinkler Alarm	1512	1010*	2235	287	..	..	..	..	2522
Watchman and Thermostats	20	10*	..	..	28	2	..	..	30
Sprinkler Alarm and Thermostats	..	..	559	43	470	132	..	..	602
Watchman, Sprinkler Alarm and Thermostats	46	81*	118	9	95	32	..	..	127
Sprinkler Alarm and Supervisory	..	..	631	13	..	..	636	8	644
Watchman and Supervisory	12	9*	..	..	..	..	21	..	21

*These include fires where sprinkler alarm or thermostat notified the watchman.

Efficiency of Alarm Service, 1897-1922 — Continued

	Watchman.		Sprinkler Alarm.		Thermostat.		Supervisory.		Total.
	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	Satisfactory.	Failure.	
Watchman, Sprinkler Alarm and Supervisory	100	240*	329	11	..	..	328	12	340
Sprinkler Alarm, Thermostats and Supervisory	..	..	77	3	67	13	79	1	80
Watchman, Sprinkler Alarm, Supervisory and Thermostats	1	1	2	..	2	..	2	..	2

*These include fires where sprinkler alarm or thermostat notified the watchman.

Table No. 4. — Number of Sprinklers Operating.

No. of Sprinklers Operating.	No. of Fires, 1921-1922. Wet	%	Dry	%	No Data	Total	%	No. of Fires, 1897-1922, incl. Wet	%	Dry	%	No Data	Total	%
1	485	40.5	59	19.6	9	553	36.1	7708	35.5	871	19.6	9	8588	32.8
2	209	17.4	43	14.3	2	254	16.7	3831	17.8	605	13.6	2	4438	16.9
3	125	10.4	23	7.6		148	9.7	2202	10.1	374	8.4		2576	9.8
4	89	7.4	29	9.6	3	121	7.9	1568	7.2	328	7.4	3	1899	7.2
5	53	4.4	13	4.3	2	68	4.5	991	4.6	208	4.7	2	1201	4.6
6	43	3.6	8	2.6	2	53	3.5	809	3.7	195	4.4	2	1006	3.8
7	29	2.4	7	2.3	1	37	2.4	545	2.5	136	3.0	1	682	2.6
8	17	1.4	9	3.0		26	1.7	518	2.4	133	3.0		651	2.5
9	14	1.2	4	1.3		18	1.2	333	1.5	97	2.2		430	1.6
10	13	1.1	5	1.7	1	19	1.2	310	1.4	88	2.0	1	399	1.5
11	9	.75	7	2.3		16	1.0	231	1.1	78	1.7		309	1.2
12	15	1.25	6	2.0		21	1.4	275	1.3	95	2.1		370	1.4
13	5	.4	8	2.6		13	.9	144	.7	71	1.6		215	.8
14	10	.8	4	1.3	1	15	1.0	172	.8	69	1.5	1	242	.9
15	7	.6	4	1.3	1	12	.8	136	.6	66	1.5	1	203	.8
16 to 20	14	1.2	20	6.6	2	36	2.4	486	2.2	204	4.6	2	692	2.7
21 to 25	16	1.3	12	4.0		28	1.8	296	1.4	146	3.3		442	1.7
26 to 30	10	.8	8	2.6		18	1.2	214	1.0	93	2.1		307	1.2
31 to 35	5	.4	6	2.0	1	12	.8	139	.6	61	1.4	1	201	.8
36 to 40	7	.6	4	1.3		11	.7	115	.5	56	1.3		171	.6
41 to 50	8	.7	6	2.0		14	.9	147	.7	91	2.0		238	.9
51 to 75	5	.4	5	1.7		10	.7	199	.9	116	2.6		315	1.2
76 to 100	2	.2	3	1.0	1	6	.4	81	.4	57	1.3	1	139	.5
Over 100	10	.8	9	3.0		19	1.2	306	1.4	218	4.9		524	2.0
No Data	11		11		8	30		11		11		374	396	
Total	1211		313		34	1558		21767		4467		400	26634	
Water shut off sprinklers													270	
Total													26904	

Table No. 5. — Number of Sprinklers Operating.

No. of Sprinklers Operating.	No. of Fires 1897-1922, incl. Wet	%	Dry	%	No Data	Total	%
1	7708	35.5	871	19.6	9	8588	32.8
2 or less	11539	53.1	1476	33.0	11	13026	49.6
3 or less	13741	63.3	1850	41.5		15602	59.5
4 or less	15309	70.6	2178	48.8	14	17501	66.6
5 or less	16300	75.1	2386	53.5	16	18702	71.2
6 or less	17109	78.7	2581	58.0	18	19708	75.0
7 or less	17654	81.2	2717	60.8	19	20390	77.5
8 or less	18172	83.6	2850	64.0		21041	80.4

Table No. 5.—Continued.

No. of Sprinklers Operating.	No. of Fires 1897-1922, incl. Wet	%	Dry	%	No Data	Total	%
9 or less	18505	85.3	2947	66.1		21471	81.9
10 or less	18815	86.7	3035	68.0	20	21870	83.4
11 or less	19046	87.6	3113	69.8		22179	84.3
12 or less	19321	89.0	3208	72.0		22549	85.8
13 or less	19465	89.5	3279	73.5		22764	86.5
14 or less	19637	90.4	3348	75.1	21	23006	87.7
15 or less	19773	91.0	3414	76.5	22	23209	88.5
20 or less	20259	93.2	3618	81.0	24	23901	91.0
25 or less	20555	94.5	3764	84.5		24343	92.6
30 or less	20769	95.4	3857	86.7		24650	93.9
35 or less	20908	96.2	3918	87.8	25	24851	94.7
40 or less	21023	96.8	3974	89.0		25022	95.3
50 or less	21170	97.3	4065	91.2		25260	96.2
75 or less	21369	98.0	4181	93.7		25575	97.2
100 or less	21450	98.6	4238	95.1	26	25714	98.0
Over 100	306	1.4	218	4.9		524	2.0
No Data	11		11		374	396	
	21767		4467		400	26634	
Water shut off sprinklers						270	26904

Table No. 6.—Effect of Sprinklers, Wet and Dry Systems.

	1921-1922 No. of Fires. Wet	%	No. of Fires. Dry	%	No Data	No of Fires. Total	%	1897-1922, incl No. of Fires. Wet	%	No. of Fires. Dry	%	No Data	No. of Fires. Total	%
Practically or entirely extinguished.	847	69.8	206	65.3	13	1066	68.4	14,718	66.1	2,925	63.7	13	17,656	65.7
Held fire in check..	330	27.2	90	28.6	8	428	27.5	6,721	30.2	1,362	29.8	8	8,091	30.0
	1177	97.0	296	93.9	21	1494	95.9	21,439	96.3	4,287	93.5	21	25,747	95.7
Unsatisfactory	36	3.0	19	6.1	9	64	4.1	835	3.7	297	6.5	9	1,141	4.3
Total	1213		315		30	1558		22,274		4,584		30	26,888	

Table No. 7.—Primary Water Supplies to Sprinklers Opened.

	No. of Fires 1921-1922	No. of Fires 1897-1922, incl.	Per Cent of No. with Data Given 1921-1922	1897-1922, incl.
Waterworks	870	12803	56.5	52.6
Gravity Tank	310	6068	20.2	25.0
Pressure Tank	296	4111	19.3	16.9
Pumps	62	1313	4.0	5.4
Steamer Connection	..	3	..	.12
No Data	20	512	..	..
Total with data given...	1558	24810		
Water shut off system...	..	270		
Total	1558	25080		

Table No. 8

Showing Effect of Sprinklers by Class of Occupancy.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Agricultural Implements	52	57.7	34	37.8	86	95.5	4	4.5	90
Alcohol (Wood) Plant	..	....	1	100.0	1	100.0	..	..	1
Apartments	11	91.7	1	8.3	12	100.0	..	..	12
Automobile and Bicycle Factories	103	57.2	70	38.9	173	96.1	7	3.9	180
Awning Factories	5	71.5	2	28.5	7	100.0	..	..	7
Bag Factories	10	66.7	5	33.3	15	100.0	..	..	15
Bakeries	62	73.0	20	23.5	82	96.5	3	3.5	85
Basket Factories	7	87.5	1	12.5	8	100.0	..	..	8
Bolt, Nut and Screw Works	17	65.4	9	34.6	26	100.0	..	..	26
Boot and Shoe Shops	516	73.3	163	23.2	679	96.5	25	3.5	704
Bottling Works	4	100.0	..	....	4	100.0	..	..	4
Braiding Mills	14	87.5	2	12.5	16	100.0	..	..	16
Breweries	5	83.4	1	16.6	6	100.0	..	..	6
Broom Factories	10	62.5	4	25.0	14	87.5	2	12.5	16
Brush Factories	17	77.3	5	22.7	22	100.0	..	..	22
Button Factories	36	80.0	7	15.6	43	95.6	2	4.4	45
Candle Factories	4	44.5	5	55.5	9	100.0	..	..	9
Candy Factories	101	71.2	37	26.0	138	97.2	4	2.8	142
Canning Factories	10	52.5	4	25.0	14	87.5	2	12.5	16
Car Houses	26	44.8	25	43.1	51	87.9	7	12.1	58
Car Works	65	60.2	39	36.1	104	96.3	4	3.7	108
Carpet Mills	155	61.5	88	34.9	243	96.4	9	3.6	252
Carriage Factories	99	62.6	46	29.1	145	91.7	13	8.3	158
Celluloid (Pyroxylin Plastic)	129	69.4	36	19.4	165	88.8	21	11.2	186
Cement and Plaster Works	2	50.0	1	25.0	3	75.0	1	25.0	4
Cereal Mills	32	68.2	10	21.2	42	89.4	5	10.6	47
Chemical and White Lead	86	59.3	48	33.1	134	92.4	11	7.6	145
Clothing Factories	728	81.5	157	17.6	885	99.1	8	.9	893
Clubs	5	83.3	1	16.7	6	100.0	..	..	6
Coffee and Spice Mills	44	64.7	21	30.9	65	95.6	3	4.4	68
Coffin Factories	45	79.0	10	17.5	55	96.5	2	3.5	57
Cold Storage Plants	4	50.0	4	50.0	8	100.0	..	..	8
Cooperage Plants	46	56.1	27	32.9	73	89.0	9	11.0	82
Cordage Works	201	65.1	97	31.4	298	96.5	11	3.5	309
Cork Factories	12	46.2	11	42.4	23	88.6	3	11.4	26
Corset Factories	8	66.7	3	25.0	11	91.7	1	8.3	12
Cotton Ginnery	10	62.5	6	37.5	16	100.0	..	..	16
Cotton Mills	3784	62.0	2258	36.9	6042	98.9	69	1.1	6111
Cotton Warehouses	140	46.5	136	45.2	276	91.7	25	8.3	301
Cotton Seed Oil Mills	38	52.0	23	31.6	61	83.6	12	16.4	73
Cutlery and Tools	22	62.8	11	31.5	33	94.3	2	5.7	35
Department Stores	371	79.6	84	18.0	455	97.6	11	2.4	466
Distilleries	7	63.7	3	27.3	10	91.0	1	9.0	11
Dolls	18	60.0	12	40.0	30	100.0	..	..	30
Drug Houses	155	79.5	36	18.5	191	98.0	4	2.0	195
Dry Cleaning Establishments	6	66.7	3	33.3	9	100.0	..	..	9
Dyeing, Bleaching and Finishing	141	53.7	109	41.6	250	95.3	12	4.7	262
Electrical Appliances	150	72.5	51	24.6	201	97.1	6	2.9	207
Electric Light and Power Plants	3	27.2	6	54.5	9	81.7	2	18.3	11
Elevators, Grain	26	38.8	25	37.4	51	76.2	16	23.8	67
Excelsior Factories	22	75.8	5	17.3	27	93.1	2	6.9	29
Fertilizer Plants	24	63.2	11	28.9	35	92.1	3	7.9	38
Flax and Linen Mills	23	44.2	29	55.8	52	100.0	..	..	52
Flour and Grist Mills	53	55.8	33	34.7	86	90.5	9	9.5	95
Forge and Smithy	14	70.0	6	30.0	20	100.0	..	..	20
Foundries	143	57.9	93	37.7	236	95.6	11	4.4	247
Fur Works	21	87.5	3	12.5	24	100.0	..	..	24

Table No. 8 — Continued.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Furniture Factories	465	64.1	203	28.0	668	92.1	57	7.9	725
Garages	125	67.8	54	29.5	179	97.3	5	2.7	184
Garbage Reduction Plants	3	60.0	1	20.0	4	80.0	1	20.0	5
Gas Plants	2	66.7	1	33.3	3	100.0	..	..	3
Glass Works	49	55.7	31	35.2	80	90.9	8	9.1	88
Glove Factories	8	66.7	3	25.0	11	91.7	1	8.3	12
Glue Factories	6	50.0	4	33.3	10	83.3	2	16.7	12
Groceries	64	80.0	11	13.8	75	93.8	5	6.2	80
Harness and Fancy Leather	83	80.7	20	19.3	103	100.0	..	..	103
Hat Factories	117	72.2	40	24.7	157	96.9	5	3.1	162
Hatters' Fur Works	12	54.5	8	36.4	20	90.9	2	9.1	22
Hotels	22	75.9	6	20.6	28	96.5	1	3.5	29
Ice Plants	2	100.0	..	....	2	100.0	..	..	2
Incandescent Lamp Factories	13	59.1	9	40.9	22	100.0	..	..	22
Institutions	8	72.7	2	18.2	10	90.9	1	9.1	11
Insulated Wire Factories	29	64.5	16	35.5	45	100.0	..	..	45
Jewelry Factories	119	87.5	12	8.8	131	96.3	5	3.7	136
Junk Shops	16	76.2	4	19.0	20	95.2	1	4.8	21
Knitting Mills, Cop Yarn	40	61.6	19	29.2	59	90.8	6	9.2	65
Knitting Mills, Full Process	466	64.3	236	32.4	702	96.7	24	3.3	726
Laundries	46	71.9	15	23.4	61	95.3	3	4.7	64
Lead Pencil Factories	16	66.7	7	29.2	23	95.9	1	4.1	24
Linseed Oil Works	16	55.2	11	37.9	27	93.1	2	6.9	29
Machine Shops	336	68.7	130	26.6	466	95.3	23	4.7	489
Match Factories	48	72.7	14	21.2	62	93.9	4	6.1	66
Mattress Factories	318	71.9	118	26.6	436	98.5	7	1.5	443
Mercantile	765	80.1	172	18.0	937	98.1	18	1.9	955
Metal Reduction Works	*8*	*66.7*	*4*	*33.3*	*12*	*100.0*	..	..	*12*
Metal Workers	738	65.1	349	30.8	1087	95.9	46	4.1	1133
Miscellaneous	382	68.7	145	26.1	527	94.8	29	5.2	556
Morocco Leather Shops	26	51.0	18	35.3	44	86.3	7	13.7	51
Motion Pictures	49	79.0	12	19.4	61	98.4	1	1.6	62
Munition Factories	16	36.4	19	43.2	35	79.6	9	20.4	44
Musical Instrument Factories	110	67.1	48	29.2	158	96.3	6	3.7	164
Office Buildings	16	80.0	4	20.0	20	100.0	..	..	20
Oil Clothing Factories	11	68.8	5	31.2	16	100.0	..	..	16
Oilcloth and Linoleum Works	31	30.4	52	51.0	83	81.4	19	18.6	102
Oil Refineries									
Animal	1	25.0	3	75.0	4	100.0	..	..	4
Mineral	5	83.4	1	16.6	6	100.0	..	..	6
Vegetable	1	14.3	5	71.4	6	85.7	1	14.3	7
Packing House and Slaughter	112	68.0	47	28.5	159	96.5	6	3.5	165
Paint and Color Works	143	69.4	56	27.2	199	96.6	7	3.4	206
Paper Box and Papeterie	141	75.8	43	23.2	184	99.0	2	1.0	186
Paper Mills	343	50.2	285	41.7	628	91.9	56	8.1	684
Patent Leather Works	7	33.3	10	47.6	17	80.9	4	19.1	21
Phonograph Works	16	76.2	4	19.1	20	95.3	1	4.7	21
Photographic Works	19	76.0	5	20.0	24	96.0	1	4.0	25
Picture Frame Factories	38	64.4	15	25.4	53	89.8	6	10.2	59
Plumbers' Supplies	18	81.8	4	18.2	22	100.0	..	..	22
Potteries	44	64.7	20	29.4	64	94.1	4	5.9	68
Printing and Lithographing	525	80.6	109	16.8	634	97.4	17	2.6	651
Pulp Mills	28	33.7	39	47.0	67	80.7	16	19.3	83
Restaurants	33	80.5	7	17.1	40	97.6	1	2.4	41
Rice Mills	1	50.0	1	50.0	2	100.0	..	..	2
Rolling, Wire and Tube Works	26	57.8	17	37.8	43	95.6	2	4.4	45
Roofing Works	20	36.3	31	56.4	51	92.7	4	7.3	55
Rubber Cloth Factories	25	59.5	17	40.5	42	100.0	..	..	42
Rubber Reclaiming Works	5	33.3	9	60.0	14	93.3	1	6.7	15

Table No. 8 — Concluded.

	Extinguished Fire		Held Fire in Check		Total Satisfactory.		Unsatisfactory.		Total No. of Fires.
	No.	%	No.	%	No.	%	No.	%	
Rubber Works	125	50.0	109	43.6	234	93.6	16	6.4	250
Saw and Planing Mills	79	44.4	58	32.6	137	77.0	41	23.0	178
Schools	3	60.0	2	40.0	5	100.0	..	..	5
Shirt Factories	43	86.0	7	14.0	50	100.0	..	..	50
Shoddy Mills	189	66.4	77	27.0	266	93.4	19	6.6	285
Silk Mills	63	72.5	20	23.0	83	95.5	4	4.5	87
Skin Mills	2	66.7	1	33.3	3	100.0	..	..	3
Soap Works	32	78.1	8	19.5	40	97.6	1	2.4	41
Stamping and Sheet Metal Works	51	58.6	29	33.4	80	92.0	7	8.0	87
Starch and Glucose Works	11	50.0	4	18.2	15	68.2	7	31.8	22
Sticky Fly Paper Factories	3	75.0	1	25.0	4	100.0	..	..	4
Sugar Refineries	19	65.5	9	31.0	28	96.5	1	3.5	29
Tanneries	38	50.0	31	40.8	69	90.8	7	9.2	76
Tenant Manufacturing	593	73.4	173	21.4	766	94.8	43	5.2	809
Theatres	42	71.2	14	23.7	56	94.9	3	5.1	59
Tobacco Factories	47	69.1	18	26.5	65	95.6	3	4.4	68
Trunk Factories	13	68.4	5	26.4	18	94.8	1	5.2	19
Varnish Works	14	56.0	9	36.0	23	92.0	2	8.0	25
Wall Paper Factories	12	66.6	3	16.7	15	83.3	3	16.7	18
Warehouses	300	71.0	103	24.4	403	95.4	20	4.6	423
Waste and Batting Mills	232	61.9	129	34.4	361	96.3	14	3.7	375
Waste Paper and Rag Shops	59	62.8	32	34.0	91	96.8	3	3.2	94
Weaving Mills	106	64.3	55	33.3	161	97.6	4	2.4	165
Whip Factories	4	66.7	2	33.3	6	100.0	..	..	6
Window Shade Factories	10	83.4	..	....	10	83.4	2	16.6	12
Woodworkers, Class A*	127	53.3	79	32.2	206	86.5	32	13.5	238
Woodworkers, Class B*	136	52.7	97	37.6	233	90.3	25	9.7	258
Woodworkers, Class C*	119	60.7	67	34.2	186	94.9	10	5.1	196
Woodworkers, Class D*	84	57.5	43	29.5	127	87.0	19	13.0	146
Woodworkers, Class E*	133	64.5	62	30.1	195	94.6	11	5.4	206
Woodworkers, Class F*	31	60.8	16	31.4	47	92.2	4	7.8	51
Woolen Mills	882	70.6	309	24.8	1191	95.4	58	4.6	1249
Wool Storehouses	27	71.1	9	23.6	36	94.7	2	5.3	38
Worsted Mills	54	52.4	37	35.9	91	88.3	12	11.7	103
Total Sprinkler Fires	17,657		8,087		25,744		1,144		26,888

*The Woodworkers are classed as follows:

Class A. Interior Woodwork, builders' supplies (including veneer works).

Class B. Box Factories (including cigar boxes).

Class C. Miscellaneous Woodworkers. Steam power tenant Woodworkers (also Woodworkers where there is a lack of detailed information as to class).

Class D. Sash, Door and Blind Factories.

Class E. Hard Wood Turning (wheels, pipes, novelties, bobbins, spools, etc., last and wood heel factories).

Class F. Pails and Woodenware. (Plates, wooden bowls, tubs, etc.)

Table No. 9

Classification of Unsatisfactory Sprinkler Fires by Occupancy.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Agricultural Implements	3	..	..	..	..	..	..	..	1	..	..	..	..	4
Automobile and Bicycle	3	1	..	..	..	..	..	2	..	..	1	..	..	7
Bakeries	1	1	..	..	..	..	..	..	..	..	..	..	1	3
Boot and Shoe Shops	8	5	2	..	..	1	..	1	..	2	5	..	1	25
Broom Factories	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Button Factories	..	..	..	2	..	..	..	..	..	..	..	..	..	2
Candy Factories	2	..	..	..	..	..	2	..	..	..	..	..	..	4
Canning Works	1	..	..	..	..	..	..	..	..	..	1	..	..	2
Car Houses	2	2	1	..	1	..	..	1	..	..	..	..	..	7
Car Works	1	1	..	..	..	..	1	1	..	..	..	..	..	4
Carpet Mills	4	1	3	..	..	..	..	1	..	..	..	..	..	9
Carriage Factories	2	3	3	..	1	..	..	1	1	..	2	..	..	13
Celluloid (Pyroxylin)	1	..	3	1	1	..	1	..	7	5	2	..	..	21
Cement and Plaster Works	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Cereal Mills	..	2	1	..	..	..	..	..	..	2	..	..	..	5
Chemical and White Lead	1	4	..	..	..	..	..	..	2	4	..	..	..	11
Clothing Factories	3	..	1	1	..	..	2	1	..	..	..	..	..	8
Coffee and Spice Mills	2	..	..	..	..	..	..	..	..	1	..	..	..	3
Coffin Factories	1	..	..	1	..	..	..	..	..	..	..	..	..	2
Cooperage Plants	1	3	..	..	..	1	..	3	..	..	1	..	..	9
Cordage Works	2	4	1	1	..	..	..	2	..	..	..	..	1	11
Cork Factories	1	..	1	..	..	..	..	..	..	1	..	..	..	3
Corset Factories	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Cotton Mills	24	17	6	2	..	1	5	1	3	..	..	1	9	69
Cotton Warehouses	14	1	2	..	..	..	1	4	1	..	..	..	2	25
Cotton Seed Oil Mills	3	4	2	..	..	..	..	..	..	..	..	..	3	12
Cutlery and Hardware	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Department Stores	4	3	..	..	..	..	..	1	..	..	2	..	1	11
Distilleries	..	..	..	..	..	..	..	..	..	..	1	..	..	1
Drug Houses	..	..	..	..	..	..	..	..	..	..	3	..	1	4
Dyeing, Bleaching and Finishing	4	3	1	..	..	1	..	1	..	..	1	..	1	12
Electrical Appliances	2	..	2	..	..	..	1	..	..	..	..	..	1	6
Electric Light and Power Plants	..	1	..	..	..	..	..	1	..	..	..	..	..	2
Elevators, Grain	..	3	4	..	1	..	2	1	1	1	2	..	1	16
Excelsior Factories	..	..	1	..	..	..	..	..	1	..	..	..	..	2
Fertilizer Plants	2	..	..	..	1	..	..	..	..	..	..	..	..	3
Flour and Grist Mills	..	2	1	..	..	..	1	..	..	3	2	..	..	9
Foundries	8	1	1	..	..	..	..	..	..	1	..	..	..	11
Furniture Factories	18	13	2	3	..	..	2	9	6	..	4	..	..	57
Garages	3	..	..	..	..	..	..	2	..	..	..	..	..	5
Garbage Reduction Plants	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glass Works	1	1	1	..	..	..	1	1	..	..	..	..	3	8

Table No. 9—Continued.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Glove Factories	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Glue Factories	1	..	..	..	..	..	..	..	1	..	..	..	..	2
Groceries	3	..	1	..	1	..	..	..	..	..	..	..	..	5
Hat Factory	1	2	1	..	1	..	..	..	..	..	..	..	..	5
Hatters' Fur Mfg	2	..	..	..	..	..	..	..	..	..	..	..	..	2
Hotels	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Institutions	..	..	..	..	1	..	..	..	..	..	..	..	..	1
Jewelry Shops	2	1	..	1	..	..	1	..	..	..	..	..	..	5
Junk Shops	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Knitting, Cop Yarn	..	1	3	..	..	..	..	1	..	1	..	..	..	6
Knitting, Full Process	6	9	5	1	1	..	1	..	..	1	..	..	..	24
Laundries	2	..	..	..	..	..	..	1	..	..	..	..	..	3
Lead Pencil Works	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Linseed Oil Works	..	..	..	..	..	..	..	..	..	2	..	..	..	2
Machine Shops	14	3	1	1	..	1	..	1	..	1	..	..	1	23
Match Factories	2	..	..	..	..	..	..	..	1	..	..	..	1	4
Mattress Factories	3	2	..	1	..	..	..	1	..	..	..	..	..	7
Mercantile	7	2	..	2	..	..	2	..	..	..	4	..	1	18
Metal Workers	16	13	2	..	..	1	3	1	3	2	2	..	3	46
Miscellaneous	7	5	2	1	..	..	3	1	4	3	2	..	1	29
Morocco Leather Shops	3	2	..	..	1	..	1	..	..	..	..	..	..	7
Motion Pictures	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Munitions Factories	2	..	..	1	..	..	..	..	4	1	..	..	1	9
Musical Instrument Factories	1	3	..	..	..	..	1	..	..	..	1	..	..	6
Oilcloth and Linoleum Works	..	4	..	..	..	..	1	3	11	..	..	..	..	19
Oil Refinery	..	..	1	..	..	..	..	..	..	..	..	..	..	1
Packing House and Slaughter	1	2	1	..	2	..	..	..	..	..	..	..	..	6
Paint and Color Works	1	2	2	..	..	..	2	..	..	..	..	..	..	7
Paper Box and Papeterie	1	1	..	..	..	..	..	..	..	..	..	..	..	2
Paper Mills	11	17	6	3	..	2	2	..	2	1	2	1	9	56
Patent Leather Works	1	..	1	1	..	..	1	..	..	..	..	..	..	4
Phonograph Works	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Photograph Works	1	..	..	..	..	..	..	..	..	..	..	..	..	1
Picture Frame Factories	1	2	1	1	..	..	..	1	..	..	..	..	..	6
Potteries	1	1	..	1	..	..	..	..	..	1	..	..	..	4
Printing and Lithographing	6	4	1	..	..	..	1	1	..	..	3	..	1	17
Pulp, Miscellaneous	1	1	2	..	..	..	..	..	..	1	..	..	..	5
Pulp, Soda	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Pulp, Sulphite	3	1	1	..	1	1	..	..	..	..	..	..	1	8
Restaurants	..	..	..	..	..	..	1	..	..	..	..	..	..	1
Rolling, Wire and Tube Works	..	..	..	..	..	..	1	..	..	..	..	..	1	2
Roofing Works	1	1	..	1	..	..	..	..	..	1	..	..	..	4
Rubber Reclaiming Works	..	..	..	..	..	..	1	..	..	..	..	..	..	1

Table No. 9—Concluded.

	Water shut off sprinklers.	Generally defective equipment and unsprinklered portions.	Defective water supply or supplies.	Sprinkler system crippled due to freezing.	Slow operation of dry system or defective dry valve.	Slow or defective operation of high test heads.	Faulty building construction, concealed spaces, vertical openings.	Obstruction to Distribution.	Hazard of occupancy too severe for average sprinkler equipment.	Sprinkler system crippled by explosion.	Exposure or conflagration.	Plugged Heads.	Miscellaneous.	Total.
Rubber Works	6	..	..	1	..	..	..	1	5	3	..	..	..	16
Saw and Planing Mills	10	7	1	..	4	1	6	2	2	..	5	1	2	41
Shoddy Mills	6	2	6	..	1	3	..	..	..	..	..	..	1	19
Silk Mills	2	1	..	..	..	..	..	..	..	1	..	..	..	4
Soap Manufacturing	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Stamping and Sheet Metal Works	1	2	1	..	1	..	..	..	..	..	2	..	..	7
Starch and Glucose Mills	..	..	..	..	..	..	..	..	1	6	..	..	..	7
Sugar Refineries	..	..	..	..	..	..	..	..	..	1	..	..	..	1
Tanneries	1	1	..	3	..	..	..	..	..	..	1	..	..	7
Tenant Manufacturing	20	6	2	2	1	..	2	1	1	..	6	..	2	43
Theatres	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Tobacco Factories	1	1	..	..	..	..	..	..	..	..	1	..	..	3
Trunk Factories	..	1	..	..	..	..	..	..	..	..	..	..	..	1
Varnish Works	..	..	1	..	..	..	..	..	1	..	..	..	..	2
Wall Paper Factories	..	..	1	..	..	..	..	1	..	..	1	..	..	3
Warehouses	9	3	1	..	2	..	..	3	..	..	..	..	2	20
Waste and Batting Mills	2	4	3	1	..	1	..	1	1	..	..	..	1	14
Waste Paper and Rag Shops	2	1	..	..	..	..	..	..	..	..	..	..	..	3
Weaving Mills	1	1	1	1	..	..	..	..	..	..	..	..	..	4
Window Shade Factories	..	..	..	1	..	..	..	..	1	..	..	..	..	2
Woodworkers, Class A*	8	8	1	..	..	1	..	5	..	3	3	..	3	32
Woodworkers, Class B*	5	8	2	1	..	1	1	1	..	3	2	..	1	25
Woodworkers, Class C*	3	4	1	..	..	..	..	2	..	..	..	..	..	10
Woodworkers, Class D*	1	7	..	1	1	..	..	..	..	2	4	..	3	19
Woodworkers, Class E*	3	2	..	..	2	1	2	..	..	..	1	..	..	11
Woodworkers, Class F*	2	..	1	..	..	..	..	1	..	..	..	..	..	4
Woolen Mills	12	16	11	1	..	2	4	..	1	..	3	..	8	58
Wool Storehouses	..	2	..	..	..	..	..	..	..	..	..	..	..	2
Worsted Mills	2	3	2	1	..	..	..	..	..	..	..	..	4	12
Total Unsatisfactory Fires	332	239	106	39	26	19	56	63	62	55	71	3	73	1144

*See detailed classification of woodworkers as given in note under Table No. 8.

Table 10.

Secondary Water Supplies to Sprinkler System.

Occupancy	Total No. of Fires	Secondary Supply		Primary Supply				Secondary Supply					
		When a Factor	% Total	Waterworks	Gravity Tanks	Pressure Tank	Misc. Pumps†	Waterworks	Gravity Tank	Pressure Tank	Steam Pump	Misc. Pumps†	Steamer Connection
Agricultural Implements	90	3	3.3	3	..	..	..	..	..	..	2	1	..
Auto and Bicycle Fac. .	180	5	2.8	2	1	1	1	1	3	..	..	1	..
Bag Factories	15	2	13.3	..	..	2	..	..	2	..	..	..	..
Bakeries	85	1	1.2	1	..	..	..	..	1	..	..	..	..
Bolt, Nut and Screw Works	26	2	7.7	1	..	..	1	1	..	..	1	..	..
Boot and Shoe Shops ...	704	13	1.9	9	3	1	..	1	6	1	3	2	..
Broom Factories.....	16	1	6.3	1	..	..	..	..	1	..	..	..	..
Button Factories	45	1	2.2	..	..	1	..	..	1	..	..	..	..
Candy Factories.....	142	5	3.5	1	..	4	..	3	1	..	..	..	1
Car Works	108	2	1.9	2	..	..	..	..	..	..	2	..	..
Carpet Mills.....	252	5	2.0	3	2	..	..	1	..	..	3	1	..
Carriage Factories.....	158	15	9.5	9	1	5	..	2	7	..	3	2	1
Celluloid Works.....	186	11	5.9	9	1	1	..	..	4	..	5	1	1
Cement and Plaster.....	4	1	25.0	..	1	..	..	..	..	..	..	1	..
Cereal Mills	47	4	8.5	2	..	2	..	..	..	1	1	2	..
Chemical and White Lead.....	145	14	9.7	2	11	1	..	..	1	..	8	3	2
Clothing	893	14	1.6	..	..	14	..	1	10	1	1	1	..
Coffin Factories	57	2	3.5	..	1	1	..	..	1	..	1	..	..
Cooperage Plants.....	82	6	7.3	1	..	5	..	3	3	..	..	..	..
Cordage Works.....	309	33	10.7	11	6	14	2	11	5	..	11	4	2
Cork Factories	26	1	3.8	..	1	..	..	..	..	..	1	..	..
Cotton Mills.....	6111	360	5.9	60	292	7	1	4	9	..	246	101	..
Cotton Warehouses.....	301	21	7.0	4	17	..	..	1	2	..	14	4	..
Cotton Seed Oil Mills...	73	15	20.6	1	12	1	1	1	1	..	10	3	..
Department Stores	466	9	1.9	2	3	4	..	..	3	1	1	3	1
Distilleries	11	3	27.2	..	1	1	1	1	..	1	1	..	..
Drug Houses.....	187	9	4.8	4	..	5	..	..	7	..	..	..	2
Dyeing, Bleaching and Finishing	262	7	2.7	3	4	..	..	1	..	..	5	1	..
Electrical Appliances ...	207	4	1.9	3	..	1	..	..	..	..	3	1	..
Electric Light and Power	11	1	9.1	..	1	..	..	..	..	..	1	..	..
Elevators, Grain	67	17	25.4	2	5	8	2	2	1	..	8	6	..
Fertilizer Plants	38	7	18.4	1	2	3	1	1	2	..	3	1	..
Flour Mills	95	9	9.5	2	3	4	..	3	1	..	2	2	1
Foundries	247	5	2.0	3	2	..	..	1	1	..	3	..	..
Furniture Factories.....	725	47	6.6	21	9	16	1	9	16	..	14	5	3
Garages.....	184	4	2.2	..	1	3	..	1	3	..	..	..	..
Glass Works.....	88	5	5.7	2	1	2	..	..	2	..	1	2	..
Glove Factories	12	1	8.3	1	..	..	..	1	..	..	..	..	..
Glue Factories	12	3	25.0	..	3	..	..	..	..	..	3	..	..
Harness and Fancy Leather	103	5	4.9	..	..	5	..	..	5	..	..	..	..
Hat Factories	162	5	3.1	1	2	2	..	1	2	..	1	..	1
Hatters' Fur Mfg.....	22	1	4.5	1	..	..	..	..	1	..	..	..	..
Inc. Lamp Factories....	22	1	4.5	..	1	..	..	1	..	..	..	..	..
Insulated Wire Factories	45	2	4.5	..	2	..	..	..	..	..	2	..	..

Table 10—Continued.

Secondary Water Supplies to Sprinkler System.

Occupancy	Total No. of Fires	Secondary Supply: When a Factor	Secondary Supply: % Total	Primary Supply: Waterworks	Primary Supply: Gravity Tank	Primary Supply: Pressure Tank	Primary Supply: Misc. Pumps†	Secondary Supply: Waterworks	Secondary Supply: Gravity Tank	Secondary Supply: Pressure Tank	Secondary Supply: Steam Pump	Secondary Supply: Misc. Pumps†	Secondary Supply: Steamer Connection
Junk Shops	21	2	9.5	1	..	1	..	..	2	..	..	..	..
Knitting Mills, Cop Yarn	65	2	3.1	..	2	..	..	..	..	..	1	1	..
Knitting Mills, F. P.	726	26	3.6	5	20	1	..	1	1	..	12	12	..
Linseed Oil Works	29	5	17.2	..	2	3	..	..	..	..	1	4	..
Machine Shops	489	11	2.2	1	3	7	..	2	2	..	6	1	..
Match Factories	66	4	6.1	..	1	1	2	3	..	..	..	1	..
Mattress Factories	443	16	3.6	2	7	7	..	4	4	..	7	..	1
Mercantile	955	31	3.3	3	1	25	2	12	8	1	..	3	7
Metal Workers	1133	34	3.0	15	10	7	2	3	8	1	18	3	1
Miscellaneous	556	30	5.4	13	7	7	3	2	10	1	12	5	..
Morocco Leather	51	2	3.9	2	..	..	..	..	..	..	1	1	..
Motion Picture	62	2	3.2	1	1	..	..	..	..	1	1	..	..
Munition Factories	44	9	20.0	..	9	..	..	..	..	..	9	..	..
Musical Instrument Factories	164	6	3.7	2	1	3	..	..	4	..	1	1	..
Office Buildings	20	2	10.0	1	1	..	..	1	1	..	..	..	..
Oil Clothing Factories	16	1	6.2	..	..	1	..	1	..	..	..	..	..
Oil Cloth and Linoleum	102	36	35.4	9	24	..	3	4	4	..	21	7	..
Oil Refineries (Vegetable)	7	2	28.6	..	1	1	..	1	..	..	1	..	..
Packing House	165	10	6.1	5	3	2	..	2	..	..	3	4	1
Paint and Color Works	206	11	5.3	1	2	8	..	4	2	..	4	1	..
Paper Box	186	6	3.2	1	1	4	..	1	2	..	1	..	2
Paper Mills	684	56	8.2	17	33	1	5	3	2	..	36	15	..
Picture Frames	59	4	6.8	..	1	3	..	..	2	1	1	..	..
Plumber's Supplies	22	2	9.1	1	..	1	..	..	2	..	..	..	..
Potteries	68	2	2.9	..	1	..	1	..	1	..	1	..	..
Printing	651	8	1.2	1	3	4	..	2	4	..	1	..	1
Pulp Mills	83	12	14.5	7	3	1	1	1	..	..	10	1	..
Rolling, Wire and Tube Works	45	2	4.5	1	1	..	..	..	..	..	1	1	..
Roofing Works	55	7	12.7	3	4	..	..	..	2	..	4	..	1
Rubber Cloth Factories	42	2	4.8	1	1	..	..	..	..	..	1	1	..
Rubber Reclaiming Works	15	3	20.0	1	2	..	..	..	..	..	3	..	..
Rubber Works	250	11	4.4	3	7	1	..	1	..	..	4	5	1
Saw and Planing Mills	178	35	19.7	15	12	..	8	2	7	..	17	8	1
Shirt Factories	50	1	2.0	1	..	..	..	..	..	..	..	1	..
Shoddy Mills	285	15	5.3	10	3	1	1	..	3	..	9	3	..
Skin Mills	3	1	33.3	1	..	..	..	..	..	..	..	1	..
Soap Manufacturing	41	2	4.9	1	1	..	..	1	..	1	..	..	..
Stamping and Sheet Metal Works	87	7	8.0	4	2	1	..	2	3	..	2	..	..
Tanneries	76	5	6.6	4	..	1	..	..	..	..	4	..	1
Tenant Manufacturing	809	12	13.5	1	2	7	2	1	6	2	3	..	..
Wall Paper Factories	18	2	11.1	..	2	..	..	..	..	..	2	..	..
Warehouses	423	26	6.2	8	9	6	3	3	13	..	7	3	..
Waste and Batting Mills	375	14	3.7	6	3	5	..	3	2	..	3	3	3

Table 10 — Concluded.

Secondary Water Supplies to Sprinkler System.

Occupancy	Total No. of Fires	Secondary Supply		Primary Supply				Secondary Supply					
		When a Factor	% Total	Waterworks	Gravity Tank	Pressure Tank	Misc. Pumps†	Waterworks	Gravity Tank	Pressure Tank	Steam Pump	Misc. Pumps†	Steamer Connection
Waste Paper and Rags .	94	4	4.3	..	..	4	..	3	1	..	..	..	..
Weaving Mills.....	165	7	4.2	..	7	..	..	..	..	..	4	3	..
Woodworkers, Class A*.	238	13	5.5	8	1	3	1	1	3	1	3	4	1
Woodworkers, Class B*.	258	18	7.0	6	5	6	1	2	8	..	3	3	2
Woodworkers, Class C*.	196	9	4.6	2	4	..	3	..	5	..	2	2	..
Woodworkers, Class D*.	146	7	4.8	5	..	..	2	1	4	..	1	1	..
Woodworkers, Class E*.	206	3	1.5	2	..	1	..	..	..	..	..	3	..
Woodworkers, Class F*.	51	5	9.8	2	2	1	..	2	1	..	2	..	..
Woolen Mills.....	1249	70	5.6	24	38	3	5	1	10	..	28	31	..
Worsted Mills.....	103	2	1.9	1	1	..	..	..	..	..	2	..	..
Total	25,552	1297		366	633	242	56	122	229	14	613	281	38

*See detailed classification of woodworkers as given in note under Table No. 9.

†See footnote under Table No. 11.

Table No. 11.

Secondary Water Supplies to Sprinkler System.

1897-1922.

Primary Supply	No. of Fires where Secondary Supply was a Factor	Secondary Supply: Waterworks	Gravity Tank	Pressure Tank	Steam Pump	Misc. Pump†	Steamer Connection
Water Works	366	8	102	5	168	67	16
Gravity Tank	633	31	2	2	405	182	11
Pressure Tank	242	70	96	5	34	27	10
Misc. Pumps†	56	13	29	2	6	5	1
Total	1297	122	229	14	613	281	38

† Miscellaneous pumps include water supplies reported as automatic steam pump, automatic electric pump, automatic fire pump, fire pump, rotary pump and pump with no designation of type.

Section III.

Efficiency of Primary Water Supply.

The three following tables are prepared from fires recorded since January 1, 1910. The tables show that waterworks is the primary supply in more than fifty per cent of the fires recorded, gravity tanks, pressure tanks, and pumps following in the order named. The tables indicate that the pressure tank is the most efficient primary supply. This fact is somewhat misleading however as pressure tanks are largely used in occupancies subject to numerous small fires which can be easily extinguished by one or two heads.

Table No. 1.

Primary Water Supplies to Sprinklers Opened.

1910-1922.

	No. of Fires	Per Cent of Fires	Av. No. of Sprinklers Opened
Waterworks	9100	54.4	8.7
Gravity Tank	3581	21.4	9.4
Pressure Tank	2988	17.9	4.2
Pumps	875	5.2	9.6
No Data	178	1.1	19.8
	16722	100.0	

Table No. 2.

Effect of Sprinklers.

1910-1922.

	W. W.	%	G. T.	%	P. T.	%	Pumps	%	No Data	%	Total	%
Ext. Fire ...	5803	63.8	2264	63.4	2386	79.9	611	69.8	84	47.3	11148	66.6
Held fire in check	2967	32.6	1210	33.7	568	19.	238	27.2	48	26.9	5031	30.1
Failure	330	3.6	107	2.9	34	1.1	26	3.	46	25.8	543	3.3
Total	9100	100.0	3581	100.0	2988	100.0	875	100.0	178	100.0	16722	100.0

Table No. 3.

Number of Sprinklers Operating.

1910-1922.

No. of Sprinklers Operating	W.W.	%	G.T.	%	P.T.	%	Pumps	% No Data		Total	%
1	2836	31.7	1021	28.9	1503	50.4	271	31.3	31	5662	34.3
2	1527	17.0	590	16.6	623	20.9	147	17.1	23	2910	17.6
3	846	9.5	338	9.5	273	9.1	80	9.2	14	1551	9.4
4	675	7.5	277	7.8	169	5.7	59	6.8	12	1192	7.2
5	415	4.6	159	4.5	86	2.9	36	4.2	7	703	4.4
6	343	3.8	165	4.6	53	1.8	32	3.7	8	601	3.6
7	246	2.7	102	2.9	40	1.3	26	3.	7	421	2.5
8	245	2.7	96	2.7	23	.8	20	2.3	6	390	2.4
9	159	1.8	60	1.7	20	.7	18	2.1	3	260	1.6
10	150	1.7	55	1.5	20	.7	10	1.2	3	238	1.4
11	95	1.1	45	1.3	14	.5	9	1.	2	165	1.0
12	138	1.5	66	1.9	14	.5	8	.9	5	231	1.4
13	77	.9	36	1.	7	.2	10	1.2	2	132	.8
14	89	1.0	31	.9	11	.3	7	.8	2	140	.8
15	62	.7	45	1.3	9	.3	8	.9	1	125	.8
16 to 20.....	254	2.8	101	2.8	22	.7	36	4.2	3	416	2.5
21 to 25.....	178	2.0	71	2.0	15	.5	20	2.3	8	292	1.8
26 to 30.....	112	1.2	48	1.4	13	.4	11	1.3	1	185	1.1
31 to 35.....	69	.8	39	1.1	8	.3	8	.9	4	128	.8
36 to 40.....	66	.7	32	.9	8	.3	11	1.3	1	118	.7
41 to 50.....	91	1.0	38	1.1	14	.5	8	.9	4	155	.9
51 to 75.....	103	1.2	62	1.7	16	.5	11	1.3	4	196	1.2
76 to 100.....	59	.7	18	.5	4	.1	3	.3	4	88	.5
Over 100	124	1.4	50	1.4	18	.6	16	1.8	10	218	1.3
No Data	141		36		5		10		13	205	
Total	9100		3581		2988		875		178	16722	

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